THE EXPLOSIVES ENGINEER

REG. U. S. PAT. OFF.

Forerunner of Progress in Mining, Quarrying, Construction

The production of limestone in Hernando County, Florida, for commercial uses is a comparatively new industry. Large-scale mining operations have been conducted for less than three decades – from 1925 to be exact. Today's figures on total annual production appear fantastic to those outside the trade. As an example, Camp Concrete Rock Company alone produces about 1,500,000 tons of marketable stone from its open-pit mines and plants near Brooksville, Florida. In the years ahead, this comparatively new and thriving industry bids fair to outstrip the dollar value of the fruit and livestock production in the county.

A review of the operating procedures of the Camp company, from native rock to freight-car loading, is presented in an article beginning on page 167.

° ° °

In the search for minerals, relatively little work has been directed at shallow depths with the reflection seismograph, although other geophysical techniques have been tried and developed. The applications that a rapid-reading shallow exploration tool would have are many, including engineering foundation work, damsite investigations, mineral prospecting, and numerous military uses.

In September and October of 1951, a seismic crew from the Stanford Research Institute of California carried on test work under field conditions in western Minnesota, using the reflection seismograph. Blasting was done with very light charges of dynamite placed 7 ft. in the air on an iron supporting stake. An accurate profile of the interface of the bedrock with the gravel drift was constructed.

For more details of the techniques employed in this exploratory expedition, please turn to page 172.

EDITORIAL STAFF: Joseph I. Horty, *Editor*; Gertrude A. Donnelly, *Assistant Editor*; Elizabeth M. Joyce, *Assistant Editor*; Edward L. Grant, *Art Editor*; Frank J. Canova, *Production Manager*; Charles E. Rabenold, *Advertising Manager*; Montgomery R. Budd, *Director*.

SUBSCRIPTION RATES: *United States and Canada*–One Year, $1.50; Single Copies, $.30. *Limited Subscriptions Only to Other Countries*–One Year, $2.50; Single Copies, $.50.

The Explosives Engineer, 913 Delaware Trust Building, Wilmington, Delaware. Printed in United States of America.

PUBLISHED BY ***HERCULES POWDER COMPANY***

COPYRIGHT 1953, BY HERCULES POWDER COMPANY

VOL. 31 NO. 6 NOVEMBER-DECEMBER, 1953

CONTENTS

Clarence Camp II–*a photograph* 164

Clarence Camp II–*a biography* 165

Editorial 166

Open-Pit Limestone Mining in Florida's Hernando County 167
By L. B. Lovett

Shallow Exploration for Iron Ore with the Reflection Seismograph 172
By W. B. Beatty

Alaska's Lake Eklutna Hydroelectric Project 175
By Bob Kederick

Four Underground Mines Receive Awards for Perfect Safety Records 180

The Moles Awards for 1954 186

Views and opinions expressed by the authors of articles in this publication are their own, and they do not necessarily represent those of the publisher.

A contract for the construction of a hydroelectric project near Anchorage, Alaska, was awarded by the Bureau of Reclamation to Palmer Constructors in 1950, on its bid of $20,365,400. Unforeseen obstacles and rising costs made mandatory a revised estimate of the bid figure to $33 million, which was approved by the Congress.

One of the principal items in the contract is the construction of a tunnel 22,800 ft. long and 12 ft. in diameter, to extend from Lake Eklutna through Goat Mountain to the future power plant near Glenn Highway. Construction crews encountered perilous obstacles last winter in the form of faults and huge water pockets. In one hectic day, 34-degree water overran the 22-in. drainage pipes and backfilled the tunnel for a distance of 450 ft. All work in the tunnel had to be suspended for 36 hours.

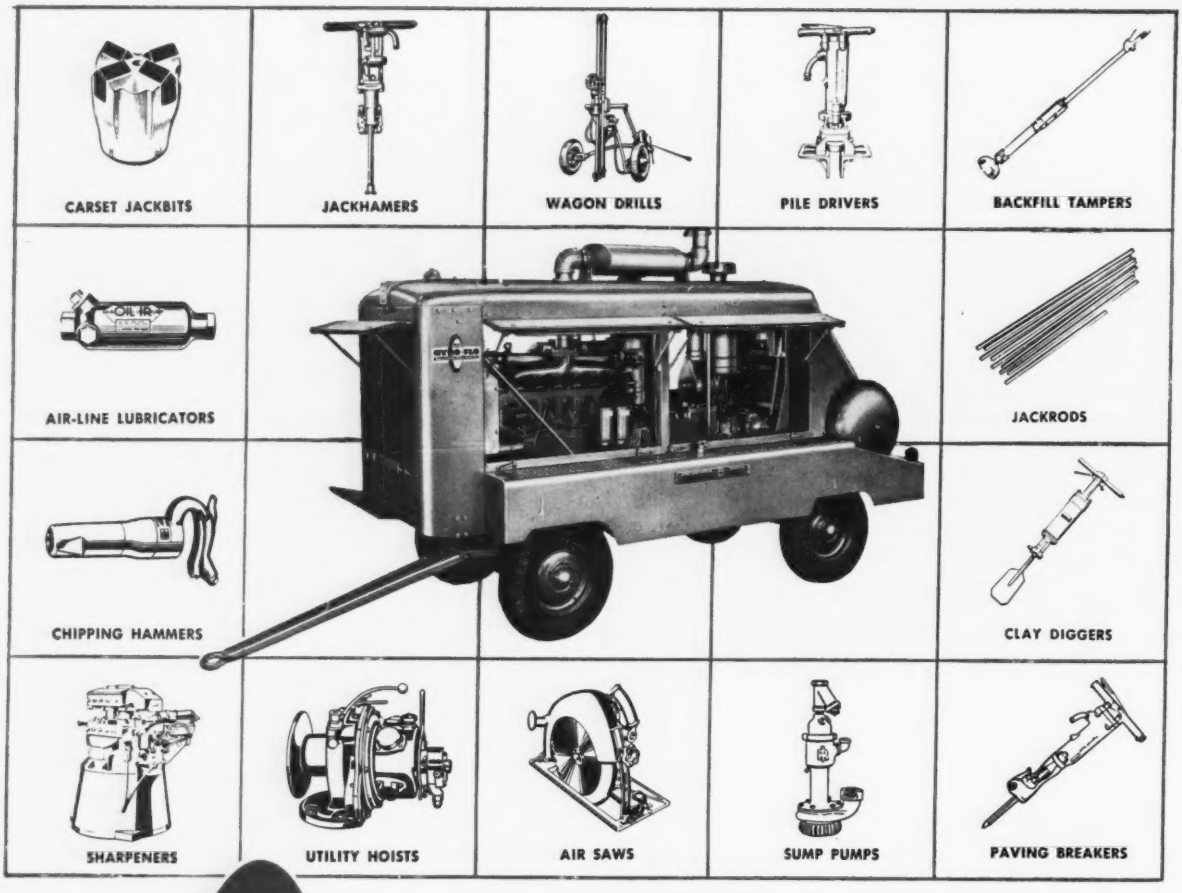
A description of the activities on this rough, tough project may be found in the article beginning on page 175.

° ° °

Each year, ceremonies are held at the properties of most of the mines and quarries that win first place in the National Safety Competition to pay tribute to the miners and to help stimulate safety-consciousness in all mines and quarries. In the article beginning on page 180, we present brief summaries of four safety award ceremonies held recently in various parts of the country.

° ° °

The Moles Awards for 1954 will be presented to J. Rich Steers of New York City and Glenway W. Maxon of Dayton, Ohio, at the annual dinner of the association on February 3, at the Waldorf-Astoria Hotel. Please turn to page 186.



GYRO-FLO

Ingersoll-Rand *Rotary* Mobil-Air

The **Heart** *of the* **CONTRACTORS' COMBINATION**

887-14

The GYRO-FLO rotary compressor – most modern portable in the world–heads up Ingersoll-Rand's *complete* line of air power equipment for the contractor. The outstanding performance of units serving in every state in the U.S.A., and many countries abroad, has proven the dependability of the GYRO-FLO advanced design.

Here's what's different about GYRO-FLO compressors. They have no valves to leak–no pistons, rings, rods or clutch to wear out. Discharge pressures are held between 100 and 110 psi throughout the entire capacity range of the machine. This means maximum efficiency in the operation of rock drills and air tools. And discharge temperatures are at least 100° lower than with other compressors, assuring longer air-hose life.

Over 75 years of experience in building air power equipment goes into every Ingersoll-Rand machine. Put this experience to work for you. Contact your nearest I-R distributor or branch office for details on the application of the Contractors' Combination to your job.

Ingersoll-Rand

11 Broadway, New York 4, N. Y.

"I always choose my Primacord as carefully as I use it . . .

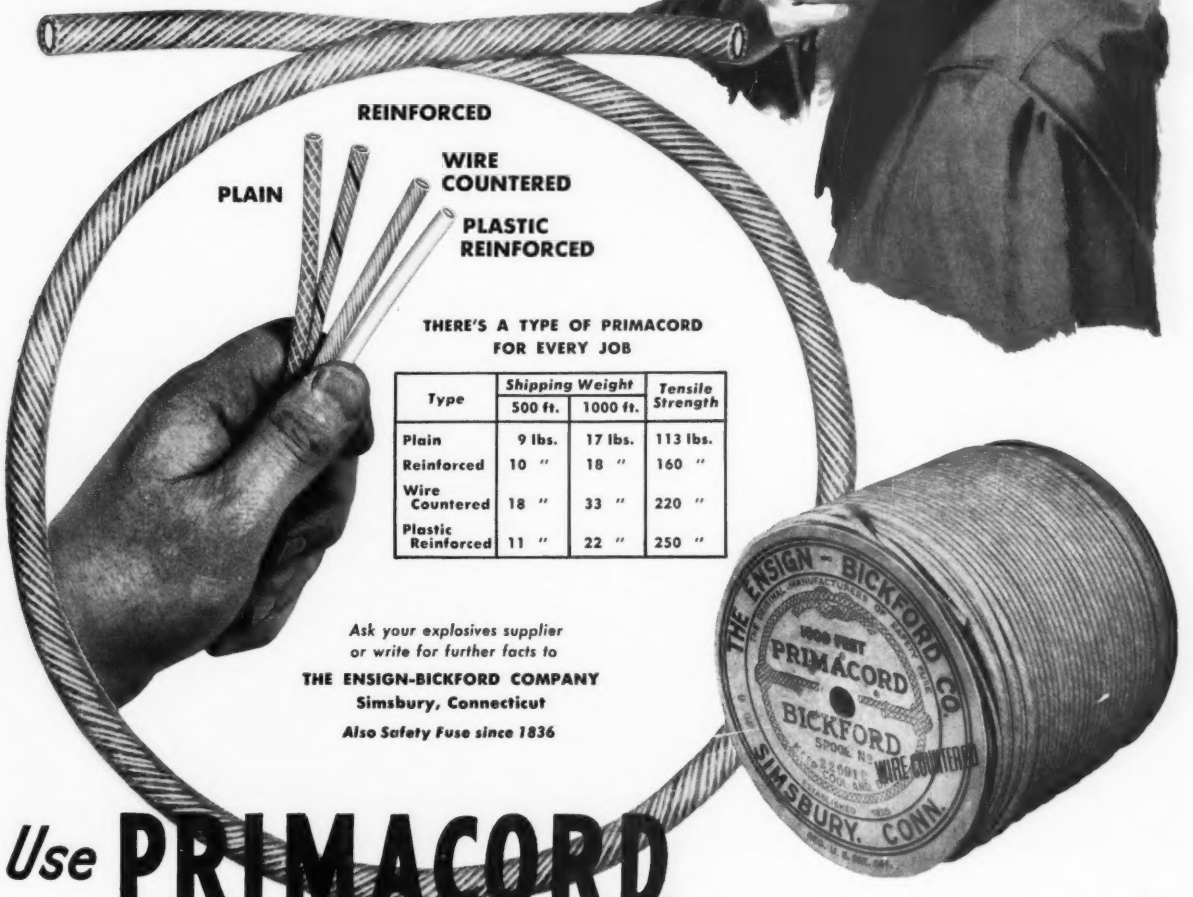
"I've used Primacord to shoot over-burden, ore, rock — and to ditch and clear right-of-way all-over the country. I get good results every time because I choose my Primacord as carefully as I use it.

"Plain Primacord I put down in small-bore or shallow holes, and also use it for the trunk line to hook them up. It's strong, light in weight, and economical. It's easy to tie tight to make a good connection.

"Reinforced Primacord is good insurance where I'm loading deep holes. It'll carry more weight and has a tougher cover to resist abrasion and cutting.

"Wire Countered Primacord is bound with fine wire. I always use it if I think there's any danger of sharp rocks or heavily reinforced explosives containers cutting the Primacord.

"Plastic Reinforced Primacord has a tough, waterproof plastic cover. I've used it in river crossings, in deep holes, or where field shots must stand a long time before blasting. It will take a lot of punishment, and is not affected by high summer heat or winter cold."



THERE'S A TYPE OF PRIMACORD FOR EVERY JOB

Type	Shipping Weight 500 ft.	Shipping Weight 1000 ft.	Tensile Strength
Plain	9 lbs.	17 lbs.	113 lbs.
Reinforced	10 "	18 "	160 "
Wire Countered	18 "	33 "	220 "
Plastic Reinforced	11 "	22 "	250 "

Ask your explosives supplier or write for further facts to

THE ENSIGN-BICKFORD COMPANY
Simsbury, Connecticut

Also Safety Fuse since 1836

Use PRIMACORD®

P-1

The PROVED and APPROVED DETONATING FUSE

CLARENCE CAMP II

Clarence Camp II

PRESIDENT, CAMP CONCRETE ROCK COMPANY; C. & J. CAMP, INCORPORATED; CAMP PHOSPHATE COMPANY; FLORIDA CRUSHED STONE COMPANY

A Biography

CAPACITY for responsibility, ability to execute responsibilities, and active participation in a variety of hobbies are a combination which assures success and happiness. One fortunate possessor of this combination is Clarence Camp II, president of Camp Concrete Rock Company; C. & J. Camp, Incorporated; Camp Phosphate Company; and Florida Crushed Stone Company.

"Mank," as he is known to his friends and associates, was born September 17, 1909, in Ocala, Marion County, Florida, the son of Jack and Ivy (Nurney) Camp. His father and mother, of Scotch and French ancestry, were early settlers in Florida, having moved there from Virginia in the 1890's. Mank received his elementary education in the local primary, grammar, and high schools. In high school, he played football and was a member of the tennis and swimming teams. An early aptitude for business was manifested by his appointment as business manager of the school annual.

Following his graduation from high school, Mank enrolled in the College of Agriculture at the University of Florida in Gainesville. After two and a half years at the university, he left to take over the job of developing Camp Ranch, Incorporated, in Gainesville. The ranch now encompasses 20,000 acres of land on which the raising of beef cattle is the primary objective. He continued to manage and direct operations at the ranch for the next eight years, living on the property.

In 1938, Mank moved back to Ocala and became active in the supervision of the limestone mine of Camp Concrete Rock Company and the phosphate mine of C. & J. Camp, Incorporated. Later he was elected secretary and treasurer of these two companies and of Camp Phosphate Company. He continued his duties as manager of Camp Ranch, Inc.

In 1951, Mank was made president and took over the active management of Camp Concrete Rock Company, C. & J. Camp, Incorporated, Camp Phosphate Company, and Camp Ranch, Incorporated. Soon afterward, the duties of executive vice president of Florida Crushed Stone Company were added to his responsibilities and in November of 1951, he was made president of the company.

Mank's other business affiliations include a partnership in both Manko Co. and in Rheinauers, Limited; membership on the boards of directors of Georgia Lime Rock Company, Perry, Georgia, and the Florida National Bank of Ocala; and association with Tyrone Rock Products Company, Tyrone, Georgia. In 1947, he was a member of a three-man delegation from Marion County to the Florida legislature. The group was voted to have been the most successful delegation in the legislature of that year.

He is a member and a past president of the Marion County Chamber of Commerce and the Ocala Rotary Club, and a member and a past exalted ruler of the Ocala Elks Lodge No. 286.

Clarence Camp II married Louise Bryant on June 11, 1940, in Ocala, Florida. They have three children: Jack Nurney, ten; Texana Gay, nine; and Gene Bryant, six. The family home is at 1303 Lake Weir Avenue in Ocala.

Mank Camp finds enjoyment and relaxation in a variety of hobbies – skeet shooting, hunting, fishing, gun collecting, and numismatics. From 1941 to the present, his principal hobby has been skeet shooting. His wife, Louise, shares his enthusiasm for this sport. In 1949, Mr. and Mrs. Camp won the National Husband and Wife Skeet Championship at Dallas, Texas, with a world's record score of 495 out of 500 targets. Mank also won the National Sub-Small or 410-Gauge Championship that year with a score of 98 out of 100 targets. Through the years, Mank and Louise Camp have been awarded 67 sterling silver trophies for their skill with a shotgun at skeet shoots held throughout the country.

Editorial

Merry Christmas—Happy New Year

The members of the editorial staff of THE EXPLOSIVES ENGINEER welcome the opportunity to extend the season's greetings to its readers. It is our earnest hope and prayer that during the year just ahead "Peace on Earth, Good Will Toward Men" may come to all of you.

A New Year's Resolution

In making plans for 1954, the operators of mines and quarries are confronted with the fact that the market price of the ore, coal, or stone that they produce and sell is, generally, beyond their control or influence. In some cases, meeting competitive conditions and operating at a profit pose difficult problems. One way to help find a solution to such a problem is to reduce operating costs.

Explosives constitute an appreciable item in the operation of a mine or quarry. Their correct selection and use are important to successful operations. To those faced with the necessity for a cost-reducing program, we again suggest a complete analysis of blasting methods and a thorough understanding of the characteristics of each type of explosive so that the proper one is selected for each job.

Manufacturers of explosives in the United States have consistently followed a program of developing technically trained men with a wide knowledge of the manufacture and use of commercial explosives. These men visit many different operations and are brought into contact with a diversity of problems. They are given opportunities to observe and to discuss the various methods used and to suggest remedies for troubles. They know the practical and economical ways of handling their products.

If industry fails to utilize the visits of these men with the "know-how," an opportunity is missed. Every operator should delegate someone to review the technical service man's recommendations and to relay applicable ones to the men on the job. In this way, operating procedures can be improved and costs reduced.

Make a New Year's resolution to find out about the many improvements that have been made in explosives in recent years and the savings that are being made possible through research and manufacturing techniques.

Prevent Weak Blasts and Misfires

Up to a certain point, the detonator is to a blast what the spark is to a motor. If the spark is weak or fails to function, the finest motor is inefficient or useless. When a detonator is weak or fails to function, an ineffective blast or a misfire is the result.

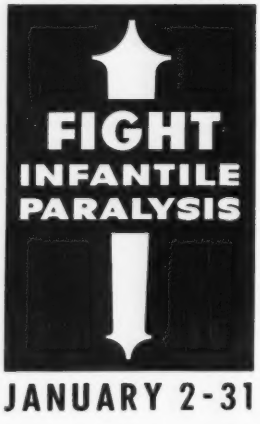
But there is this great difference. A faulty ignition system can be repaired, usually, and all is as before; a faulty detonator is seldom detected until the damage has been done. Such damage may extend all the way from the loss in strength of the explosives in a small blast, incompletely detonated, to similar losses involving thousands of pounds. Holes loaded with explosives that misfire take a heavy toll in time and labor from the blaster; they also increase the hazard of his work.

In the final analysis, the performance of any explosive depends upon the performance of the detonator used.

Accidents Can be Eliminated

Complete elimination of disabling accidents in industry is distant, but at least not visionary as applied to routine production. Some experimental work, and the introduction of unfamiliar processes, may always be dangerous. However, when all productive enterprise, all design, and all working methods are viewed first and most critically from the safety standpoint, and when safety outranks expediency, the accident-free goal will be within reach.

Those industries that use explosives are, as a group, inherently hazardous. Workmen in them are faced with a combination of varying natural hazards and heavy mechanical equipment, for which satisfactory, foolproof guards cannot always be devised. Yet the possibility of accident-free operation has been demonstrated many times, and in almost all branches of these industries. These examples have not been the result of chance, or of exceptionally favorable conditions. In every instance they have resulted from the belief that safety was a major operating problem, one that took precedence over any other. Strong backing by the management personnel has enabled the operating staff to proceed on a sound, well-planned, and far-seeing program of accident prevention. Given such support, it is the firm faith of most responsible safety engineers that disabling accidents can be eliminated.



"Don'ts" for Explosives Users

Don't allow near the danger area of a blast any persons not essential to the blasting operations.

Don't fire a blast until all surplus explosives are in a safe place, all persons and vehicles are at a safe distance or under sufficient cover, and until adequate warning has been given.

Don't return to the face until the smoke and fumes from the blast have been dissipated by adequate ventilation.

Don't attempt to investigate a misfire too soon. Follow all applicable rules and regulations, or, if no rules are in effect, wait at least an hour.

PRIMARY BLAST: This picture of a blast in a bank of limestone at Camp Concrete Rock Company's property near Brooksville, Florida, is typical of the excellent results obtained from primary blasts. Uniformity in both the movement and the fragmentation of the rock formation within the blast area is consistently realized.

OPEN-PIT LIMESTONE MINING IN FLORIDA'S HERNANDO COUNTY

Camp Concrete Rock Company's operations, begun modestly in 1925, currently average an annual production of 1,500,000 tons of various sizes of limestone for commercial purposes

L. B. LOVETT*

FLORIDA's citrus- and cattle-rich Hernando County is the locale of a comparatively new and thriving industry that bids fair to outstrip the dollar value of its fruit and livestock production in the years ahead. The birth of the new industry was not auspicious nor was it celebrated; in fact, the event wasn't even noticed. Its arrival was more or less accidental and years were to pass before it grew to commercial size.

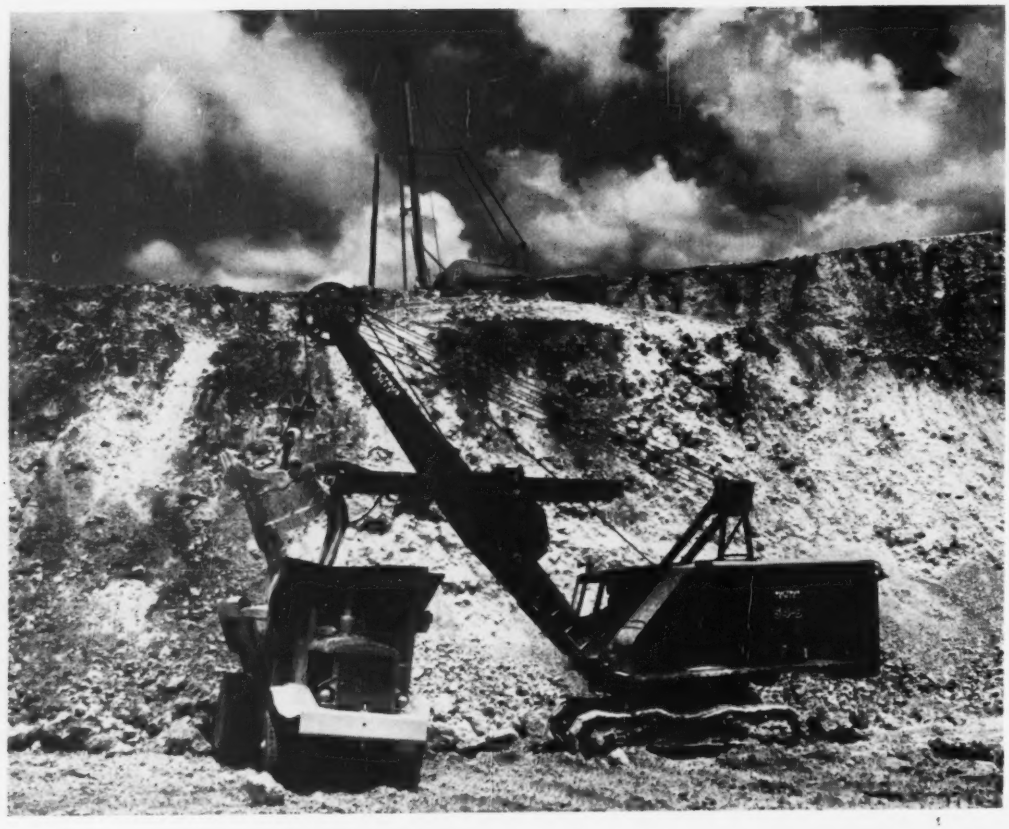
Legend has it that many years ago a party of prospectors came to the south central section of Hernando County in search of phosphate deposits. Instead of finding phosphate, their picks uncovered another mineral. While they couldn't have been aware of it then, the mineral they found accidentally was to be, eventually, just as rich in dollar returns to miners as the mineral they had hoped to find.

Today that mineral, known as limestone, is an indispensable one for the construction trade. Contractors and builders have found it to be an excellent surface material for roadways, as a stabilizer for asphaltic pavements, and as a component of concrete.

Camp's Production Approximates 1,500,000 Tons a Year

The commercial production of limestone, as far as operations near Brooksville, Florida, are concerned, can be called young by any standards. Thirty years would span the time that limestone has been used for the construction of roads in Florida. And less than three decades – from 1925 to be exact – would cover the number of years that limestone mining operations in Hernando County have been conducted on a large scale. Production has been increased year after year as improved methods have been adopted and more efficient equipment and machinery employed. Today's figures on total annual output appear fantastic to those outside the trade. As an example, Camp Concrete Rock Company alone produces approximately 1,500,000 tons of marketable stone each year for use in highway and bridge construction, in making ready-mix concrete, and in the manufacture of cement building

*General Manager
Florida Crushed Stone Company
P. O. Box 608, Ocala, Florida



RECOVERING LIMESTONE: The Camp company uses Bucyrus-Erie power shovels to scoop up blasted limestone from the floor of a pit at the rate of 2½ cu. yds. for each bite. The operators load the broken rock into heavy Euclid trucks. On top of the bank a churn drill is drilling holes into the formation preparatory to making another blast.

PAN FEEDER: A view of one of the Euclid trucks dumping blasted rock from the open-pit mine into a pan feeder, or loading apron, which, in turn, dumps into pit cars of 5- and 10-cu. yd. capacities. The loaded pit cars are pulled up the incline, left, by a 1,100-ft. steel cable for delivery to the primary crusher.

PRIMARY CRUSHER: A close-up of the primary crusher where the first step in reducing the rock to commercial sizes takes place. After the crushing operation, a conveyor belt 4,000 ft. long moves the crushed rock to the main plant where the processing of the limestone is completed. Plant capacity varies, depending upon the size of the limestone being processed.

RAPID TRANSPORTATION: Speeding past the camera at a rate of 400 ft. a minute, the 4,000-ft. conveyor belt carries partially processed limestone to other crushing units for further reductions to required sizes. The difference in the sizes of the stone is apparent – the smaller stone on the belt serving as a bed for the larger sizes on top.

blocks. The products of the Camp company are sold exclusively by Florida Crushed Stone Company, Ocala, Marion County, Florida.

While deposits have proved spotty rather than solid in the areas mined to date, limestone matrixes (veins) often measure 40 to 50 ft. and more in depth, and sometimes run hundreds of yards in length before playing out.

The production of limestone for commercial purposes is a complex operation, from native rock to freight-car loading. It begins with stripping the overburden down to the matrix. The depth of the overburden usually ranges from 18 in. to 3 or 4 ft. After bulldozers have knocked down trees and tangled undergrowth, tractors and pans scrape up the overburden so that drilling and blasting crews can begin operations. The spoil that is pushed back from the lip of the quarry is used to fill in sinks and swampy areas on the property.

Blasting the face of the cliff with industrial explosives is a precision operation, because the successive steps in the production of marketable limestone depend upon the results obtained from primary blasts.

Drilling and Blasting

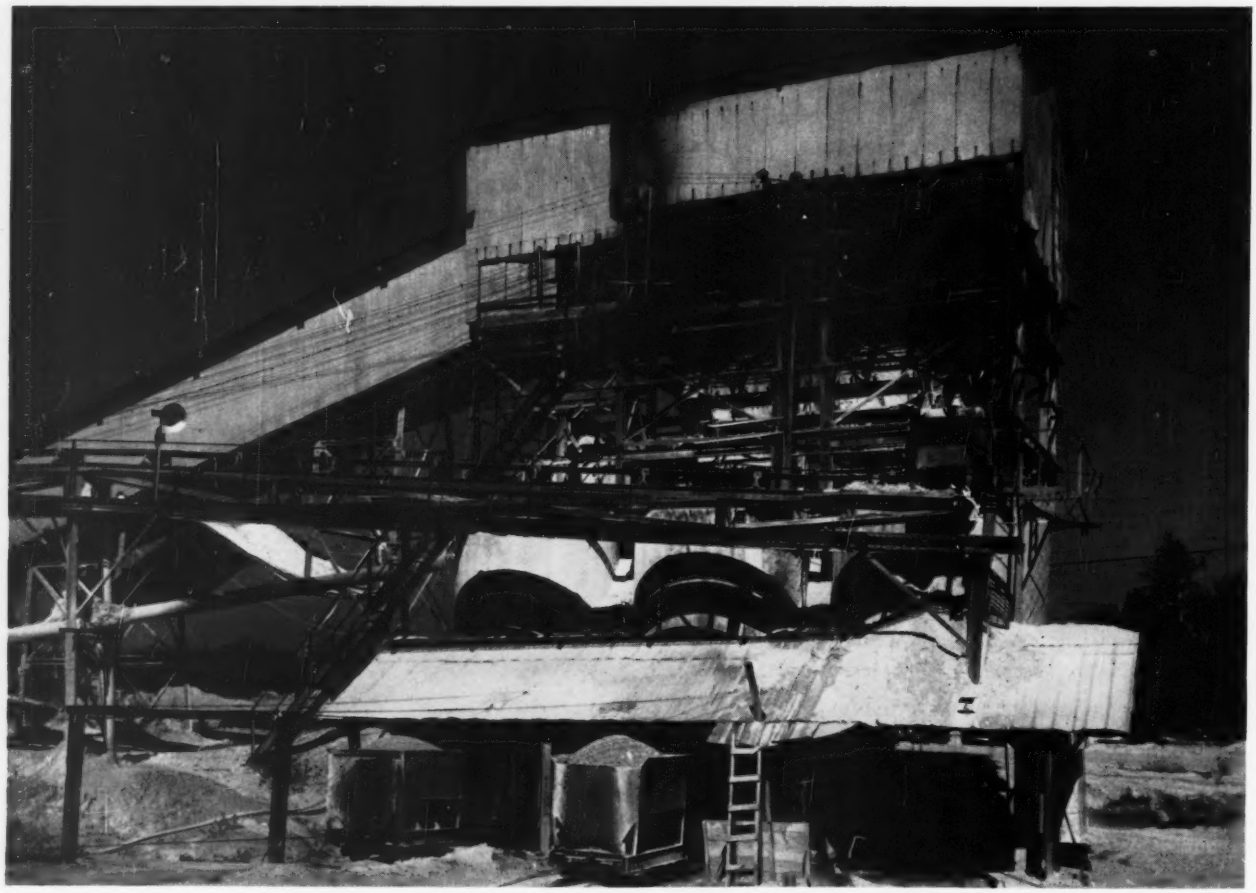
The first activity of the Camp company's crews in its pits near Brooksville, Hernando County, Florida, involves drilling a series of vertical holes on a staggered, or zigzag, pattern into the limestone from the top of the ledge, 10 to 15 ft. back from the rim of the working face. Each hole extends to within 2 to 3 ft. of the bottom of the matrix, sometimes reaching a depth of 45 to 50 ft.

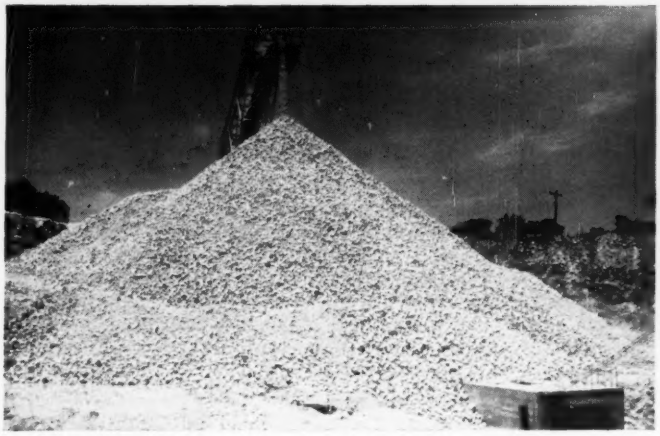
After the holes have been drilled, a cavity is made in the bottom of each by loading and firing a dynamite charge. Such procedure is referred to as springing a hole. The cavity permits loading a greater amount of explosives in the bottom of each hole. This concentration of the charge produces better breakage at the base of the formation being blasted. For the final charge in all the holes in a primary blast, Camp uses from 4,000 to 5,000 lbs. of free-flowing dynamite, detonating the explosives electrically. Results are consistently satisfactory, each blast producing from 10,000 to 15,000 tons of broken limestone. Dynamite consumption averages about 70,000 lbs. a month.

Recovering Blasted Limestone

The recovery of broken limestone for the various steps in the processing operations begins when blasting has been finished. Bucyrus-Erie electric shovels scoop up the blasted rock from the floor of a pit at the rate of 2½ cu. yds. a bite. The shovels load the rock into heavy Euclid trucks, driven by 275-hp. motors, with a rated capacity of 17 cu. yds. The "Eucs" transport

A SILO: After separation through shaker screens, various sizes of finished stone are dropped into 30-ton-capacity silos where they are graded and loaded into bull cars for delivery to the stock piles.





SURGE PILE: Stone is deposited on a surge pile at a rate of 350 tons an hour and is drawn through the tunnel in the foreground at a rate of around 100 tons an hour when the other pits are in operation.

READY FOR DELIVERY: Looking down on some of the 130 gondola cars of finished product loaded during each day's operation. Each holds approximately 60 tons of limestone.

the broken limestone from the quarry to the pan feeder, or loading apron, which, in turn, dumps into pit cars of 5- and 10-cu. yd. capacities. The loaded pit cars are pulled up to the primary crusher where the first step in reducing the rock to commercial sizes takes place. The pulling of the cars is done by an 1,100-ft. steel cable powered by electricity.

The Camp company activities are carried on from three pits simultaneously, with cars operating from two of the pits. The third pit, a recent installation, consists of a primary crusher and a scrubber screen. The stone mined in this pit is moved on a 4,000-ft. conveyor belt into the main plant where the processing of the stone is brought to completion.

One of the features of this conveying system is a surge pile of about 8,000-ton capacity. This makes possible a much greater hourly production from the No. 3 pit because the stone is deposited on the surge pile at a rate of about 350 tons an hour. It is drawn through a concrete tunnel by means of an electric vibrating feeder at a rate of around 100 tons an hour. It is necessary to hold this feed at the 100-ton figure because output from pits Nos. 1 and 2 comes within 100 tons of supplying the capacity of the main crushing-and-sizing plant.

Processing Procedures

The first of a number of special treatments in the overall processing operation occurs at the primary crusher. Rock under 8 in. in diameter is separated from oversizes by a live-roll grizzly, and it by-passes the primary crusher. Rock under 8 in. in diameter goes direct to the blade mill where the larger sizes are also carried after the first reduction at the primary crusher.

The blade mill consists of a giant cylinder, which revolves and washes the crushed rock before it is routed to the conveyor belt and into the mill for the subsequent steps in the reduction and refining processes.

Before reaching the second crusher, another rock-separation process takes place. All sizes less than 3½ in. in diameter are removed from the larger sizes and sent to a washer log. The larger sizes go through a second crushing operation. Also, at this point, clay and too-soft rock, not already dissolved by the constant washing and agitation processes, are cast aside by hand.

Crusher No. 3 theoretically reduces all rock to 1½ in.; crusher No. 4 reduces it to 1 in. in diameter. When the plant is making material of smaller sizes, 1-in. rock is sent on to a fifth crushing operation or to a hammermill for further reduction in size.

During the refining process, many sandlike limestone particles have been knocked off the rock. This material is settled out and marketed in two grades: washed screenings and regular screenings.

From the final crushing and washing operations inside the plant, the finished product is separated into grades and goes to a loading device known to the trade as a silo. From there, the stone is loaded into bull cars and transferred to company stock piles.

Separation by grades is done by means of suspended vibrating screens, each having a mesh small enough to retain rock of a specified size but large enough to pass small-size stone to screens below. The operation is continued until all of the limestone is finally separated into the six grades that are marketed commercially.

Rigid Inspection Tests Assure High-Quality Product

Once in the stock pile, the rock is ready for shipment. Stock piling is done directly over a 500-ft.-long underground tunnel that leads to a railroad siding within the main yard. When an order for limestone is received, a chute under the required grade is opened and a conveyor belt carries it to freight cars. En route to the freight cars, the stone is washed again. It must pass rigid inspection tests before it is cleared for shipment.

By means of the chutes under the stock piles and the conveyor belt in the loading tunnel, various grades of limestone can be blended to meet practically any specification.

Water and electrical power are prime requisites for the limestone-refining process. In full operation, the plant uses 8,000 gals. of water a minute. The water is obtained from wells 200 ft. deep, using deep-well turbine pumps. The transformer which supplies power to the mill carries a sufficient load to light and operate a city with a population of 5,000.

Shallow Exploration for Iron Ore with the Reflection Seismograph

Brief summary of the adaptation of a new geophysical technique in mineral prospecting in Minnesota

W. B. BEATTY*

THE seismograph geophysical instrument and its application to the search for mineral wealth have been developed principally by the petroleum companies over the past thirty years. Because of the usually greater depth of oil-bearing strata, the instrument has been used chiefly as a deep-level exploration tool. Relatively little work has been directed at shallow depths with the reflection seismograph, although other geophysical techniques, including the magnetometer, gravimeter, and various electrical methods, have been tried and developed. The applications that a rapid-reading shallow exploration tool would have are many, and include engineering foundation work, damsite investigations, mineral prospecting, and numerous military uses.

Among the variations of technique is the practice of air shooting instead of exploding the powder charge which is the energy source in a shot hole drilled sometimes many feet into the earth's crust. For several years the Stanford Research Institute of California has maintained a seismic crew to conduct investigations of the specific techniques of air shooting and to carry on test work under field conditions. In September and October of 1951 such a reflection survey was made in western Minnesota.

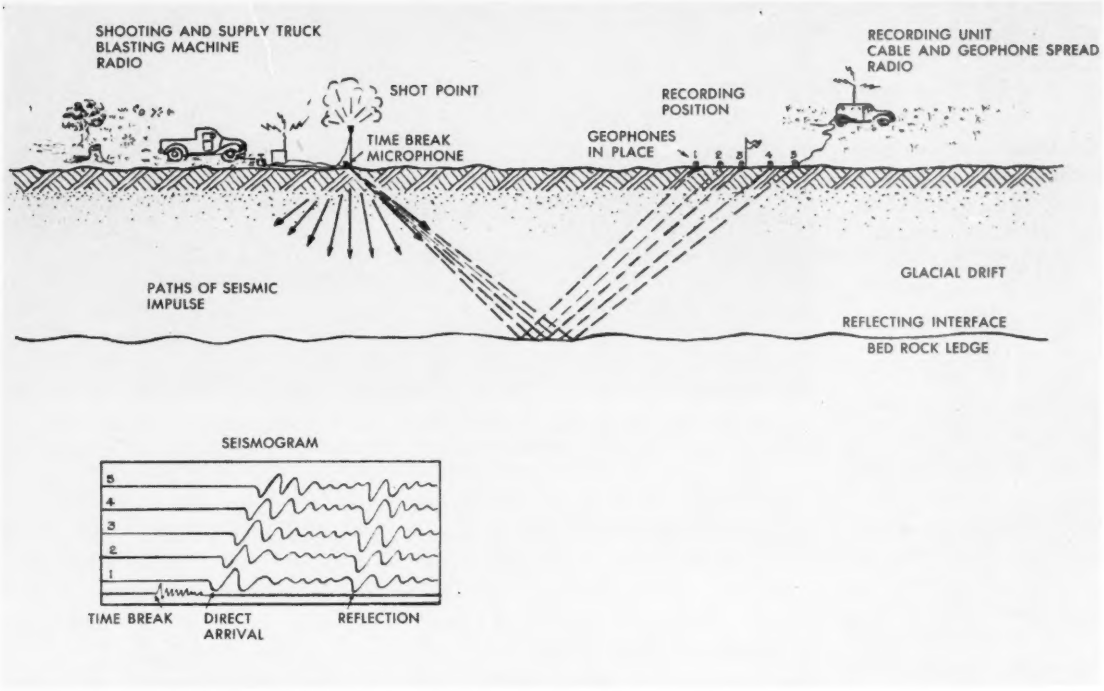
The Problem

Here pre-Cambrian iron-bearing formations are covered with a thickness of several hundred feet of glacial drift ranging in size from the fine, uneven clays and silts in varvelike layers to great boulders in very uneven arrangement. While the bedrock surface is a good reflecting interface, it was somewhat complicated by a fossil-weathered layer actually in the bedrock, which gave two separate reflecting horizons a few feet apart. Clay lenses within the drift mantle, sometimes extensive, also gave reflections. Ground surface ranged from bogs to firm, hard soil with a normal amount of brush cover. In this general area some 70 miles of line were surveyed by a seismic crew to obtain a picture of the bedrock profile.

Equipment

Shallow work in the range of a few hundred feet requires certain modifications of standard seismograph equipment. Field experiments showed frequencies in this area to be relatively high – in the order of 100 cycles – and corresponding filter settings were used. Elsewhere, however, considerable frequency variation has been experienced and a special set of instruments was built, which included high-frequency galvanometers, filters that can peak as high as 500 cycles, and a camera that is speeded up to deliver paper at a rate of 4 ft. a second.

*Menlo Park, California



FIELD EQUIPMENT: A generalized diagram of field equipment in position to obtain a seismic record by the Poulter air-shooting technique.

SEISMIC RECORDS: Reproduction of seismograms recorded in Becker and Ottertail Counties, Minnesota. Marked reflection is from glacial drift-bedrock interface: A represents good quality; B, average quality; C, marginal quality.

These are mounted in a passenger car, but are light and, if the need arises, are readily portable.

The geophones used were the standard, light, pin-type variety recently developed by the industry for normal soil work. For this particular project a set of five phones, 25 ft. apart, on an especially spaced cable was used; this distance and a shot-point spacing of 400 ft. being selected after several days' experimentation. All geophones and the shot are "in line." Small, portable two-way radios were used to obtain the time-break for each shot. A four- or five-man crew can operate and do the interpretation for this work.

AIR SHOOTING: Air shooting involved the firing of very light charges of dynamite – usually 2 to 4 oz., sometimes 2 lbs. The dynamite is placed on an iron supporting stake extending 7 ft. above ground. No special grade or strength of dynamite is required.

Shooting

Shooting was done with charges of dynamite placed 7 ft. in the air on an iron supporting stake. Air shooting requires a very light charge – most of this work was done with from 2 to 4 oz. of dynamite making up each charge. At times, wind and ground noise, or very boggy ground, would require as much as a 2-lb. charge. It was found that an offset shot point kept air-borne surface waves from spoiling the energy returns. The explosives used were not unusual, with requirements being obtained at local hardware stores.

Velocity Determinations

Velocity of the drift cover was measured by the standard method with a geophone lowered into a drill hole. Since the available drill holes for measuring velocity were all located in the smaller, northern portion of the area being studied, and velocity was found to decrease southward at a rate of about 50 ft. a mile, it was necessary to be very careful in velocity determinations. The actual test values were applied to the greater undrilled portion of the area by constructing a "velocity contour" map. There was a range in velocity across the entire surveyed area from 5,950 ft. to 3,800 ft., steadily decreasing southward. Shot holes were spaced from one-half mile to a mile, the latter generally being the one used.

Findings

An accurate profile of the interface of the bedrock with the gravel drift was constructed. This was checked in the four northern drill holes at that time, the results of which were:

Depth of Bedrock

Location	*Core Drill*	*Reflection Seismograph*
Location 1	544	554
Location 2	600	610
Location 3	450	465
Location 4	427	423

These close results indicate that the application is very much warranted where the detail of the subsurface is required in this degree. Control core drilling is still required for the dual purpose of velocity and correlation data, and the method may be properly said to extend the use of core drilling rather than to replace it.

The application of reflection shooting may be used in mineral prospecting, ground-water exploration, and in various problems of foundation work. As in this case, the initial work in any area would be the empirical determination of proper geophone and shot-point spacing to obtain the best possible energy return. Accurate velocity determination is also of prime importance. With these factors properly evaluated, the interpretation work should be very rapid and accurate. A few core holes plus this adaptation of larger scale and deeper exploration techniques should enable a crew to obtain considerable subsurface knowledge of a larger area in a reasonable length of time.

(Continued on page 187)

STEAM DRILL: A steam drilling rig, typical of the drills used for many years in exploring for iron ore. The one shown above is still in use in Minnesota.

ALASKA'S LAKE EKLUTNA HYDROELECTRIC PROJECT

The Bureau of Reclamation's $33 million construction job in the rugged Chugach Mountains, 30 miles northeast of Anchorage, will require more than 700,000 lbs. of industrial explosives

BOB KEDERICK*

More than 140 million kilowatt hours of electrical energy will be available for power-hungry Anchorage and the Matanuska Valley, Alaska's chief population center, when the Bureau of Reclamation's hydroelectric project in the rugged Chugach Mountains harnesses the flow of Lake Eklutna. The lake, 7 miles long and 1 mile wide, has an active reservoir capacity of 123,000 acre-feet. It is located about 33 miles northeast of Anchorage in the Eklutna Creek Basin, cradled in a steep-sided, gorgelike valley headed by a vast snow field surrounded by glaciers.

*Night News Editor, Anchorage Daily News Anchorage, Alaska

To provide a major source of power for Alaska's largest city and greatest agriculture sector, the Bureau of Reclamation recommended this hydroelectric project in 1950, after detailed surveys of the severe power shortage in the area had been completed. A study of the more complete regulation of the waters in the upper Eklutna Creek also led to the recommendation of the project.

The City of Anchorage already has a power plant in operation at Lake Eklutna with an installed capacity of 2,000 kilowatts. This capacity is now considered inadequate because of the tremendous growth of the area, which is the military and railroad center of Alaska. A low-storage dam at the lake outlet, a downstream diversion dam, and a tunnel to the power plant are the existing facilities at this great natural site. A contract between the City of Anchorage and the Bureau of Reclamation for the sale of the city-owned plant has been approved. Ratification of the sale awaits final action at a

THE EKLUTNA PROJECT: An artist's conception of the Bureau of Reclamation's $33 million Lake Eklutna hydroelectric project now under construction in Alaska's rugged Chugach Mountains, located about 33 miles northeast of Anchorage.

GOAT MOUNTAIN ROCK: This view of the portal at the north end of the tunnel includes a section of the sedimentary and metamorphosed rock formation in Goat Mountain through which the 22,800-ft.-long tunnel had to be drilled and blasted. At various locations inside the tunnel, workmen operated under a cover approximating 4,600 ft.

municipal election scheduled for this winter. The contract specifications call for the city to receive a block of 16,000 kilowatts of power from the Bureau of Reclamation for 24 years, at which time the city's Federal Power Commission license for Lake Eklutna power rights will have expired.

Construction Costs $33 Million

After studies by the Bureau of Reclamation and the United States Geological Service were completed, a contract for the construction of the hydroelectric project in the Chugach Mountains was awarded to Palmer Constructors in 1950, on its bid of $20,365,400. Unforeseen obstacles and rising costs made mandatory a revised estimate of the bid figure to $33 million, which was approved by the Congress. The Palmer Constructors, a joint-venture firm under the sponsorship of Peter Kiewit Sons of Omaha, Nebraska, include Morrison-Knudsen Company, Incorporated, Boise, Idaho, and Coker Construction Company, Anchorage, Alaska.

One of the principal items in the contract is the construction of a tunnel 22,800 ft. long and 12 ft. in diameter, to extend from Lake Eklutna to the future power plant on Knik Arm near Glenn Highway, one of the territory's major arteries. The completed bore will be lined with reinforced concrete to measure 9 ft. in diameter. The tunnel pierces Goat Mountain, a peak scaling 5,340 ft. on the fringe of the Chugach Range. Almost all of the mountain peaks in the Chugach Range are capped with snow fields and surrounded by glaciers which are wedged into deeply cut valleys.

In addition to the tunnel, other major specifications in the contract include a penstock 900 ft. long, proceeding from the base of Goat Mountain to the tunnel portal at an angle of 53 degrees; a surge tank 180 ft. deep and 30 ft. in diameter, located approximately 200 ft. above the tunnel portal; a gate shaft 211 ft. long and 9 ft. in diameter, constructed into Lake Eklutna and sealed off until the tunnel is completed; an intake structure, a precast conduit, 200 ft. long and 9 ft. in diameter, installed 70 ft. below the normal surface of Lake Eklutna; trash racks and strain, a six-section unit installed 90 ft. below the normal surface of Lake Eklutna.

It has been estimated that more than 700,000 lbs. of industrial explosives will be used by the contractors on this project, with about 400,000 lbs. of dynamite used in driving the tunnel. This item of explosives requirements is an indication of the scope of the construction work involved.

Work on the tunnel began in October, 1951. With drilling and blasting operations proceeding from both the portal at the north end and the shaft at the lake end, the tunnel pitches downward on a slope of 4 in. every 100 ft. Since the spring of 1953, progress in the tunnel has averaged 55 ft. a day at the north heading and 35 ft. a day at the south heading. So far, the best combined heading advance in a day has been 126 ft. The record advance in a six-day period is 370 ft.

Complex Geological Formation

The tunnel is being driven through rock-formed, water-pocketed Goat Mountain in the steep Chugach Range peak which overlooks the Matanuska Valley and the Knik River. The complexity of the geological formation in this mountain structure presents difficulties because of the lack of distinctive beds of continuity.

At the north portal, mine crews began the job of piercing Goat Mountain at a location approximately 850 ft. up from its base — one of the highest headings worked in recent years. At various locations inside the tunnel, Palmer Constructors' workmen operated under a cover approximating 4,600 ft.

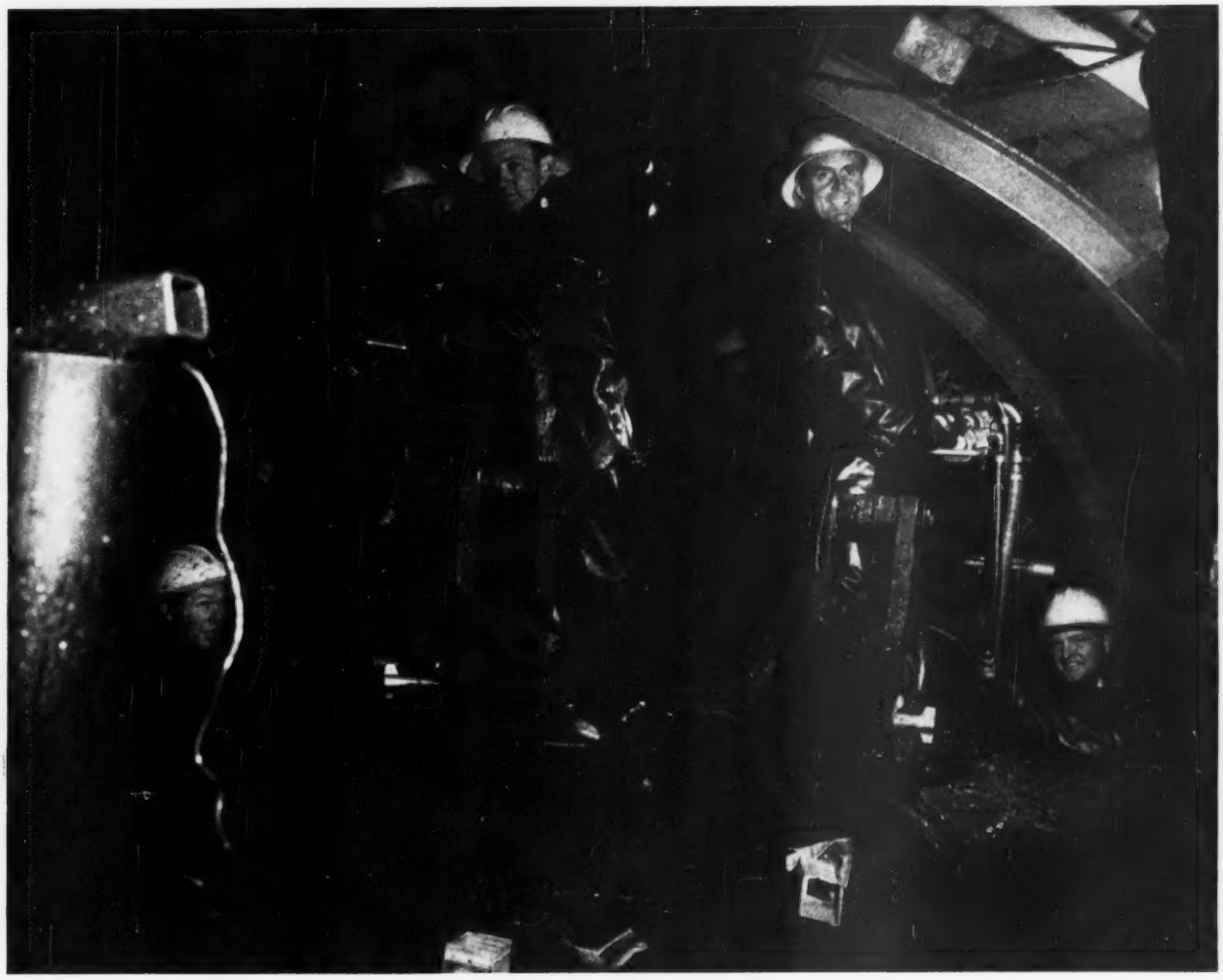
Since the winter months of 1952-1953, tunnel advance has been satisfactory on the elongated bore, the most ambitious underground operation of its kind ever attempted in Alaska. However, construction crews ran up against perilous obstacles last winter in the form of faults and huge water pockets, many of the latter letting loose millions of gallons of water. In one hectic day, the near-freezing water poured from a long series of faults and water pockets, overran the 22-in. drainage pipes and backfilled the tunnel for a distance of 450 ft.

The blast which opened the biggest water pockets was fired November 9, 1952, a black-letter day in the history of the Eklutna project. An estimated 14,000 gals. of water a minute gushed out from the pockets, washing out rail, power, and air lines. Surging torrents of water unloosed from vast underground reservoirs poured out of the tunnel mouth, piling mud and silt to depths of several feet. A temporary

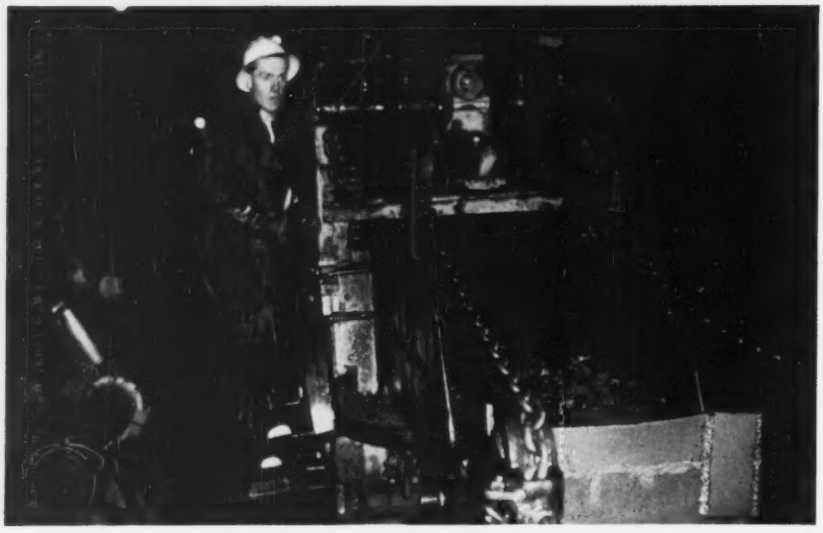
waterfall was created when the crystal-clear water streamed from the portal of the tunnel to cascade down the steep slopes of Goat Mountain. All equipment in the tunnel was submerged and almost insurmountable working conditions were created by this avalanche of 34-degree water.

After the crews had worked through the water zones, tunnel advance made steady progress through the slate, shale, argillite, and graywack formations. Between 35 and 40 holes are drilled 10 ft. deep into the face. Drilling is accomplished with Ingersoll-Rand DA-35 drifters equipped with 10-ft. steel and Timken tungsten-carbide bits, mounted on rail-mounted single-deck drilling jumbos built on the job. Five drifters are mounted on each jumbo, one jumbo operating at the

FROM THE GATE SHAFT: At the Lake Eklutna end of the project a gate shaft was sunk vertically. From the base of the shaft, drilling and blasting operations were carried on to drive a 12-ft.-diameter tunnel to a predetermined station under the bed of the lake.



JUMBO DRILLING: Rounds of 35 to 40 blast holes were drilled 10 ft. deep into headings in the north tunnel with Palmer Constructors' crews using five Ingersoll-Rand drifter drills mounted on a single-deck rail-mounted jumbo.



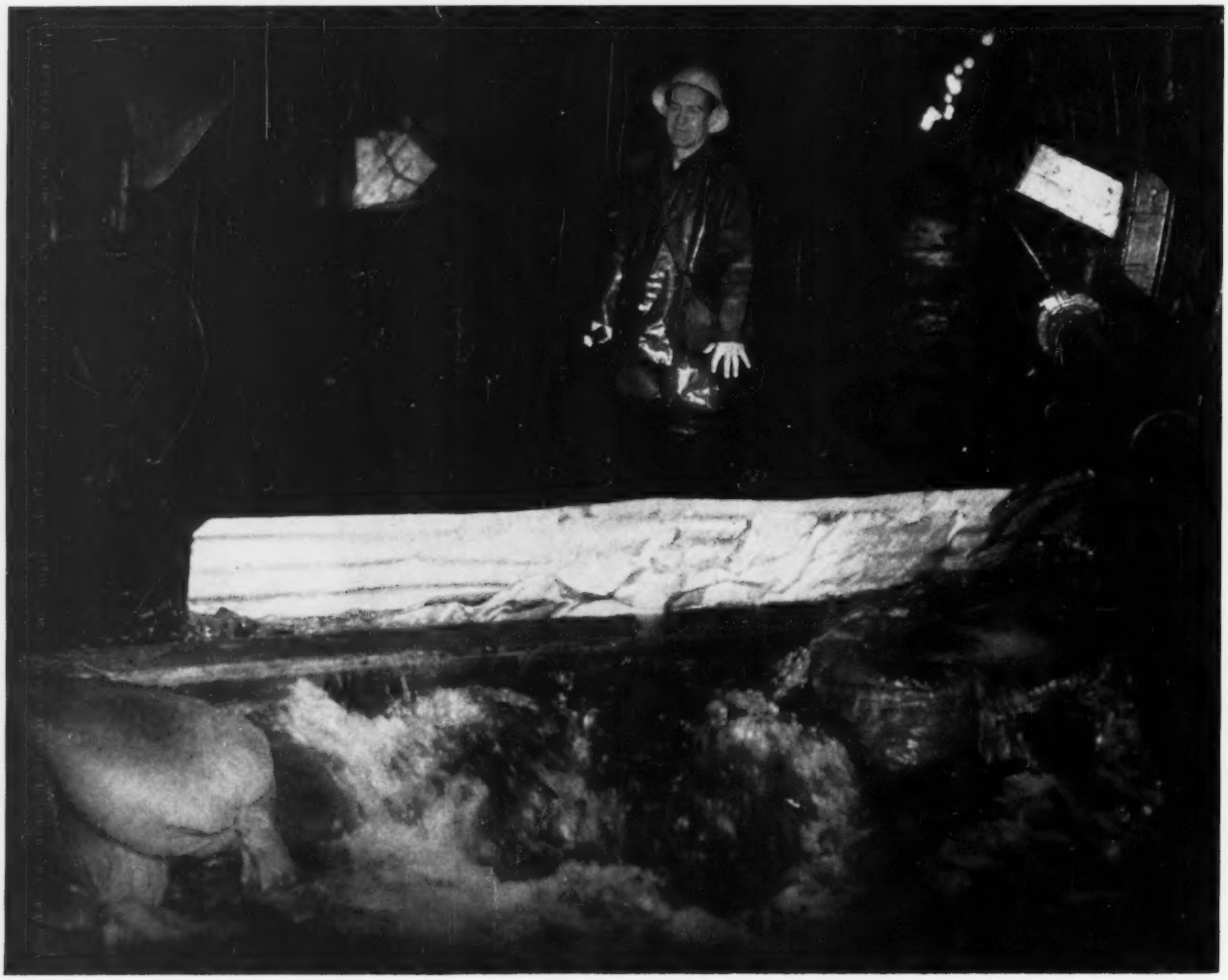
BELT-LOADING MUCK: After a blast in a heading, the muck was excavated and belt-loaded from 60-hp. Conway mucking machines into 4-cu. yd. side-dump rail cars. After a car was moved into loading position, operators averaged the loading of one car a minute.

portal headings and the other at the shaft headings. The holes in a round are drilled in a circular pattern, with the cut or breaker holes slanted toward the center of the heading. Once a jumbo is in operation at a heading about 15 minutes is required to drill a round for blasting.

Blasting in a Heading

In loading explosives in the drill holes in a heading, the usual procedure is to use a ratio of 4 lbs. of 40 per cent gelatin dynamite, packed in standard-size cartridges, to each cubic yard of material in place. When hard rock was encountered deep in the interior of the tunnel, the explosives loading ratio was raised to 4½ lbs. per cu. yd.

Each dynamite cartridge is inserted and tamped individually in a drill hole.



SEVERE WATER CONDITIONS: After an advance of about 2,000 ft. in the north tunnel, water pockets were encountered. On November 9, 1952, following a blast in a heading, 34-degree water gushed out from pockets at a rate of 14,000 gals. a minute. The surging water washed out air-, power-, and rail-lines, and created almost insurmountable conditions.

Delay electric blasting caps, from first through eighth periods of delay, are used as primers. The cap leg wires are connected to a 220-volt A.C. firing line, which operates from a station about 1,500 ft. from the heading. A typical blast in the rock formation yields about 9 ft. of tunnel advance. In the water-pocket zones of the tunnel, the length of the drill holes in a round was reduced to 4 ft. To date, no secondary blasting has been required.

When a heading has been drilled and the explosives charges loaded, all workmen move to the rear of the firing line located about 1,500 ft. from the heading. After a blast has been fired, the shot firer returns to the heading and checks results before mucking crews, electricians, and the "bull gang" move up to the working face. The blasted material is excavated and belt-loaded from 60-hp. Conway mucking machines into 4-cu. yd. side-dump rail cars. From the time an empty car is moved into loading position, a mucking machine averages the loading of one car a minute.

Muck Disposal

Trains of 16 loaded cars, powered by Goodman locomotives, transport the muck from a working face to the dump area, located a few hundred feet from the portal of the tunnel. A combination battery-and-trolley system has been put into operation, utilizing Gould storage batteries. A portable siding is maintained in the tunnel within a short distance of the mucking machines. Rail lines, 50-lb. and 24-gauge, are laid to within 10 ft. of a working face. To minimize dust prior to the mucking operations, heavy streams of water are directed onto the piles of blasted material with a hose, particularly when the formation in a heading is dry.

Compressed air for the equipment inside the tunnel is supplied by Sullivan Y-type 950-c.f.m. compressors, which build up 110 pounds of pressure. Two Chicago-Pneumatic portable compressors are kept at hand as stand-bys. Ventilation in the tunnel is provided by two Roots-Connorsville ventilating fans through 6-in. pipe lines, with one fan at each end of the tunnel. Both fans, with 3-lb. water-gauge pressure, blow 13,500 cu. ft. of air a minute. Electric power for lighting purposes and for the operation of equipment and machinery inside the tunnel is generated by two Ingersoll-Rand 600 KW diesel engines driving General Electric alternators.

BACKFILL FROM FLOOD: An avalanche of near-freezing water, pouring out of a long series of faults and water pockets, overran the 22-in. drainage pipes, submerged the equipment, and backfilled the tunnel for a distance of 450 ft. Within 36 hours of the outbreak, it was necessary to suspend all work on the project.

The surge tank is located directly over a part of the northern end of the tunnel. The pilot shaft, 4 by 7 ft. in diameter, extending 180 ft. from the

(Continued on page 188)

BRACING THE TUNNEL: As the flow of water subsided, miners went back into the tunnel and erected 6 by 6-ft. timber spilling in the roof and sides, and breastboards at the headings in the shattered rock. The danger spots were slowly passed and, as the tunnel was advanced farther back into the mountain, normal working conditions were the rule.

Four Underground Mines Receive Top Safety Awards for Perfect Safety Records

Company officials pay tribute to employes at mining properties in Alabama, Michigan, Florida, and Pennsylvania for outstanding accomplishments in accident prevention on the job

THE results of the National Safety Competition of 1952 were published in the May-June issue of THE EXPLOSIVES ENGINEER. The news that the six winners achieved records of no lost-time injuries during the year presented an encouraging picture to everyone interested in the promotion of safety in the mines and quarries of the United States. Last year's contest was the first in the 28-year history of the competition that the winner in each of the six classifications had achieved perfect safety records.

Each year, public presentation ceremonies are held at the properties of most of the winning mines and quarries to pay tribute to the winners and to help stimulate safety-consciousness in all mines and quarries.

In our September-October issue, we published a review of ceremonies at Lakewood Park Pavilion near Pottsville, Pennsylvania, when The Philadelphia and Reading Coal and Iron Company's Hunter Tunnel mine was awarded the Sentinels of Safety trophy for being the winner in the anthracite underground mine group. We present here brief summaries of four other safety award ceremonies held recently in various parts of the country.

Bituminous-Coal Mine Winner

The honor of ranking first in the bituminous-coal underground mine group of the National Safety Competition was signalized at the Short Creek mine of the Tennessee Coal and Iron Division, United States Steel Corporation, on August 31, with the formal awards of the Sentinels of Safety trophy and flag. The program of events included the presentation of the Joseph A. Holmes Certificates of Honor to the Short Creek mine, in recognition of its overall safety achievements; to H. C. Hillman, mine foreman, whose crew had accomplished 288,926 man-hours of work without a lost-time accident; and to H. A. Havron, who had worked in and around the coal mines for 44 years with a perfect safety record on the job.

The ceremonies were conducted from a platform erected in front of the change house at the mine property in Adamsville, Jefferson County, Alabama, with 125 employes, company officials, and guests in attendance. Elwood B. Nelson, general superintendent of TCI's coal mines, officiated as master of ceremonies.

After extending congratulations to the winners, Mr. Nelson introduced the company officials and prominent guests. He then called upon Milton C. McCall, chief of District 7, U. S. Bureau of Mines, to present the Joseph A. Holmes Certificates to the mine and to individual employes for their outstanding safety records.

The master of ceremonies then introduced Edward L. Grant, associate editor of THE EXPLOSIVES ENGINEER, to make the awards of the Sentinels of Safety trophy and flag to the Short Creek coal mine employes.

Mr. Grant paid tribute to the Short Creek employes for their perfect safety record during 1952. "Your mine was competing against 133 other mines in the bituminous-coal underground group in a nation-wide safety contest," he said. "After the records were tabulated in Washington, your total of 588,788 man-hours of work with no lost-time injuries was the best of them all."

Continuing, Mr. Grant said: "Most of us realize that safety is everybody's business. But, sometimes, in the rush

AWARDING THE TROPHY: Following the awards of the trophy and flag, Edward L. Grant, associate editor of The Explosives Engineer, extends congratulations to Dewey W. Hill, superintendent of Short Creek coal mine, at right, with P. R. McDonald, superintendent of TCI's coal washers, an interested observer of the ceremonies.

of getting things done some of us disregard that fact. The safety record made by you Short Creek miners last year is an outstanding example of perfect teamwork. I extend my congratulations, and those of my associates, to each Short Creek miner, to your supervisors, and to the company officials for a magnificent record of achievement in eliminating lost-time injuries in your work in the mine."

In accepting the awards of the trophy and flag, Superintendent Dewey W. Hill spoke of the pride experienced by everyone associated with the Short Creek coal mine upon winning first place in the National Safety Competition, in the bituminous-coal underground mine group. "It is a real pleasure for me, as the representative of the employes," he said, "to receive the award of this beautiful trophy and flag. We will continue to work together as a team to maintain the record of no accidents in our mine."

THE HOLMES CERTIFICATES: Superintendent Hill places a Joseph A. Holmes Certificate of Honor alongside others won by Short Creek mine in past years. Seated in rear, left to right, A. V. Wiebel, president, and C. R. Davis, director of safety and plant protection, TCI; M. C. McCall, chief of District 7, U. S. Bureau of Mines; R. H. Bumgardner, manager of the safety and casualty bureau, TCI; R. W. McKee, manager, Birmingham district, Hercules Powder Company; H. C. Hillman, foreman, Short Creek coal mine; R. E. Kirk, manager, raw materials division, and H. A. Havron, mine machinist, TCI. Also on the platform but not clearly shown, John Pugsley, executive vice president; J. M. Spearman, vice president, operations; J. H. Williamson, manager, industrial relations; Eugene P. Reed, assistant manager, raw materials, TCI.

Week-Long Series of Awards

The Short Creek program was one of a week-long series of presentations at TCI's coal and iron mines, in which Joseph A. Holmes Certificates of Honor were presented to operating units and individuals with outstanding safety records. During the week, eight certificates were presented to the supervisory personnel of the TCI mines whose crews had worked for long periods without a disabling injury. Supervisors receiving the awards were Frank Turner, Jr., assistant mine foreman, H. C. Hillman, and G. D. Myrick, all of the coal mines; and Pearlie Carson, maintenance foreman, W. T. Morris, assistant mine foreman, T. D. Jordan, mine foreman, J. T. Nabors, and W. G. Littles, all of the ore mines.

Individual certificates were also presented to Charles H. Jones, a hoist engineer; Albert H. Johnson, crusher and shakerman; Willie Hayes, senior washer foreman; Ira B. Tidwell, motor inspector helper; and Mr. Havron. Each of these men had completed 40 or more years of work at the mines without a lost-time injury.

A special presentation was made to Luther McAnally, Jr., assistant mine foreman at the Concord coal mine, for having saved the life of a fellow employe. Previously, the company had presented Mr. McAnally with the TCI silver medal for meritorious action, the first time in ten years that such a presentation had been made.

The ceremonies at Adamsville were of special significance to TCI as they marked the first time that one of its coal mines had won the Sentinels of Safety trophy and flag. However, it

INTERESTED SPECTATORS: As the ceremonies got under way, the photographer had to hurry to take a picture of some of the Short Creek coal mine employes who were grouped in front of the speakers' stand at Adamsville, Alabama.

was the tenth such award to be received by a unit in the TCI raw materials division—No. 5 limestone mine, Bessemer, Alabama, has been the winner of the award five times in the underground nonmetallic group, and Dolonah quarry, also at Bessemer, has won the trophy four times in the quarry classification. The ten awards of the coveted trophy bear eloquent testimony of the strong backing of TCI's management personnel in well-planned and far-seeing programs of accident prevention in all its operations.

Metal Mine Winner

The 330 employes of The Verona Mining Company's Buck mine, a Pickands Mather and Company iron ore operation at Caspian, Michigan, were honored at ceremonies conducted on the lawn in front of the Verona clubhouse in Caspian on Saturday morning, September 26, 1953. The highlight of the interesting program was the award of the Sentinels of Safety trophy to the mine for having been operated for a total of 685,388 manhours of work during 1952 without a lost-time injury. This perfect record of accomplishment in accident prevention in an underground metal mine was the best among 62 similar properties enrolled in the 1952 National Safety Competition. L. A. Schutz, safety supervisor for the PM company's operations on the Menominee Range, directed proceedings as the master of ceremonies for the occasion.

Mr. Schutz read letters of congratulation to the winning mine employes from Elton Hoyt and H. C. Jackson, officials of the company in the home office in Cleveland; A. D. Chisholm, general manager for PM in the Lake Superior district with headquarters in Duluth; and J. J. Forbes, director of the U. S. Bureau of Mines in Washington, D. C.

Kenneth M. Duncan, PM consultant and retired assistant general manager, reviewed the company's efforts to establish and maintain safe working conditions at all of its properties. "The records achieved have made us proud and happy, especially so as regard the accomplishments at Buck mine," the speaker said.

The master of ceremonies next introduced Joseph I. Horty, editor of THE EXPLOSIVES ENGINEER, to make the awards of the Sentinels of Safety trophy and flag to the mine. In his remarks, Mr. Horty commented briefly on the 28-year history of the National Safety Competition and the significance of the trophy. "It represents," he said, "a mother with her baby in her arms waiting in the doorway of her home for the safe return of the husband and father from his shift in a mine. Keep before you, on the job and off the job, a mental picture of your wives and children waiting for you to return home safely from your work. If you do that, it will help you to continue to avoid chance-taking; you will stay healthy and happy; and you will win this bronze trophy many times again."

K. M. DUNCAN: After reviewing the company's efforts to maintain safe working conditions at its mining properties, Mr. Duncan, PM's consultant and retired assistant general manager, congratulated the Buck miners for their perfect record last year.

Teamwork Pays Off

H. J. Richards, general superintendend of Buck mine, and Leo Serafiny, president of the CIO Local, accepted the trophy and flag on behalf of the supervisory force and the employes of Buck mine. Mr. Richards spoke of his pride in being a member of the Pickands Mather organization "which always is found among the leaders in accident-prevention work in the mineral industry." Mr. Serafiny expressed his gratitude for the cooperation and loyalty of the Buck miners in carrying out company safety rules and regulations. He elaborated on the excellent relations between the workmen, the union, and the management personnel. It's the kind of harmonious relationship," he said, "which makes each man feel he is an important member of a team. You can't beat that kind of spirit. It's a foregone conclusion that many more good things will come your way."

Brief congratulatory remarks and sincere hopes for future successes were expressed by W. F. Eckert of Cleveland, Ohio, director of safety for PM

ACCEPTING THE TROPHY: H. J. Richards, general superintendent, Buck mine, and Leo Serafiny, president, CIO Local, right, accept the Sentinels of Safety trophy from Joseph I. Horty, editor of The Explosives Engineer.

W. F. ECKERT: After complimenting the winners, Mr. Eckert, PM's director of safety, reminded the Buck mine employes that records reveal good production and good safety always go hand in hand.

E. W. FELEGY: Mr. Felegy, the representative of the U. S. Bureau of Mines in the Duluth district, presented Certificates of Achievement in Safety to each man in the Buck mine organization.

at all of its operations; E. A. Anundsen of Duluth, Minnesota, safety engineer for the company in the Lake Superior district; Didace Dion, area representative of the CIO steelworkers; and Frank Johnson, member of the local mine employes' safety committee.

Certificates of Achievement in Safety were presented by E. W. Felegy, chief of the Duluth district, U. S. Bureau of Mines, to Mr. Serafiny for later distribution to each Buck mine employe. In making the presentation, Mr. Felegy reminded the men that today's ceremonies marked the ninth time that a Pickands Mather mine had won first honors in the National Safety Competition. He concluded his talk by saying: "All of your friends in the iron ore country are pulling for you to keep up the good work of making many more safety records."

The program was brought to a close by a group of five local Boy Scouts who raised the Sentinels of Safety flag up the flagpole in front of the clubhouse to fly in the breeze under Old Glory, as one of the Scouts sounded the bugle call "To The Colors."

Open-Pit Mine Winner

Employes of the Noralyn mine, International Minerals and Chemical Corporation, Bartow, Florida, were honored at ceremonies on Friday morning, October 16, in celebration of their having won first place in the National Safety Competition of 1952, in the open-pit mine group. F. B. Bowen, department manager of International's operations in Florida, officiated as master of ceremonies.

After extending congratulations to each Noralyn miner and complimenting the group for having worked 715,588 man-hours without a lost-time injury during 1952, Mr. Bowen introduced J. I. Horty, editor of THE EXPLOSIVES ENGINEER, to make the awards of the Sentinels of Safety trophy and flag. In his comments to the winning miners, Mr. Horty said: "Noralyn mine has been enrolled in the National Safety Competition for two years. At the end of the first year in the contest, 1951, its record showed only one accident which caused a loss in working time. After all the records for 1952 had been tabulated, they showed that Noralyn mine had been operated for more than 715,000 man-hours with no lost-time injuries. That record topped all the other 89 mines in your group and you were declared the winner of the Sentinels of Safety trophy."

Continuing, the speaker said: "The results achieved at Noralyn mine point clearly to the fact that each man in the organization had a feeling of personal responsibility to live up to his company's safety rules and regulations. That kind of cooperation pays big dividends in health and happiness to you, your families, and your friends."

J. L. Robison, assistant mining superintendent of Noralyn mine, accepted the awards of the bronze trophy and flag on behalf of the mine employes.

Three Mines Honored

In awarding individual Certificates

RAISING THE FLAG: Shown here are local Boy Scouts, sons of Buck mine employes, as they raise the Sentinels of Safety flag up the flagpole in front of the Verona clubhouse to fly in the breeze under the Stars and Stripes.

F. B. BOWEN: The department manager of International's Florida operations extended congratulations to the Noralyn miners.

THE TROPHY AWARD: J. L. Robison, assistant superintendent of Noralyn mine, right, accepts the award of the bronze Sentinels of Safety trophy from Joseph I. Horty, editor of The Explosives Engineer.

of Achievement in Safety to the Noralyn miners, J. R. Thoenen, regional chief, U. S. Bureau of Mines, commented upon the remarkable safety results made by three units in the corporation's Rock Phosphates Department in the 1952 National Safety Competition. "You men at Noralyn mine won first place, your Peace Valley mine came in third, and your Achan mine received the award of an honorable mention certificate."

At the conclusion of his remarks, Mr. Thoenen presented the individual certificates for the Noralyn miners to Mr. Robison for later distribution to each man in the unit. A third-place certificate was presented to D. G. McMullen, assistant mine superintendent at Peace Valley, and the honorable mention certificate was accepted by J. F. Hatch, assistant mine superintendent at Achan mine.

Nonmetallic Mine Winner

Monday night, October 26, 1953, was a memorable one for the 460 employes of the Annandale mine of U. S. Steel's Michigan Limestone Division, located at Boyers, Pennsylvania. Accompanied by their wives, officials of the division, and visiting dignitaries, the miners were the guests of the division's management personnel at a dinner in the Penn-Grove Hotel, Grove City, Pennsylvania. Following the dinner, the group assembled in the auditorium of the Grove City High School to receive various awards for remarkable achievements in accident prevention on the job. H. C. Farrell, manager of Michigan Limestone Division's industrial relations department, directed the program as master of ceremonies.

In opening the program, Mr. Farrell brought out the fact that when the Annandale miners laid down their tools at the end of work on October 26, it marked the 1,019th calendar day without a lost-time injury at the mine. The string of accident-free days began on January 11, 1951, and totals almost two and one-half million man-hours on the job. The previous world's record was 1,112,162 man-hours of work without a lost-time injury by the Sugar Creek mine of Missouri Portland Cement Company at Sugar Creek, Missouri.

In his remarks to the group, C. F. Beukema, general manager of operations of the Michigan Limestone Division, pointed out that the safety record at Annandale mine, which is continuing to grow each day, is being

J. R. THOENEN: The regional chief of the U. S. Bureau of Mines, right, awards individual Certificates of Achievement in Safety, for later distribution to each miner, to J. L. Robison, assistant superintendent of Noralyn mine.

AFTER THE CEREMONIES: When the ceremonies were completed, a group of Noralyn miners gathered around the bronze trophy for close inspection. The consensus among all the employes was, "We'll try hard to keep it with us."

achieved during a period of peak production. "I want to express my sincere compliments and those of everyone in the division to each man in the Annandale mine organization," he said, "for carrying out our program of 'safe work' so magnificently. Your record is a major milestone in the history of the Michigan Limestone Division."

In making the awards of the Sentinels of Safety trophy and flag to Annandale mine, J. I. Horty, editor of THE EXPLOSIVES ENGINEER, said: "Besides establishing a new world's safety record for underground nonmetallic mines, you Annandale miners also came up with the best record among 47 mines enrolled in your group in the 1952 National Safety Competition. Your total for last year was 746,135 man-hours worked without a lost-time injury. You miners, supervisors, and division officials are deserving of all the good things that are being awarded to you tonight."

Other Outstanding Awards

Other awards made at the Annandale ceremonies included individual Certificates of Achievement in Safety from the U. S. Bureau of Mines; Award of Honor from the National Safety Council; Certificate of Honor from the Commonwealth of Pennsylvania; and Joseph A. Holmes Safety Association Award from the U. S. Bureau of Mines. Also, individual Joseph A. Holmes Award certificates were presented to four supervisory employes: A. J. Guerin, plant foreman; L. E. Hooks, chief electrician; L. L. Kohlmeyer, assistant mine foreman; and A. C. Isacco, section foreman. Mine employes Angelo Calderoni, Mariano Calderoni, Frank D. Obidean, and Veneil A. Peace also received the award.

In accepting the awards on behalf of his Annandale associates, J. W. Baird, manager of the mine, explained that every possible safety precaution is taken in the mine to assure safe working conditions for the employes. "However," he said, "we want to pay tribute to each employe for his splendid cooperation in making our program work. Without that cooperative effort we would not be here tonight to celebrate our safety records."

MR. BAIRD ACCEPTS: The award of the Sentinels of Safety trophy was accompanied by smiles of happiness from J. W. Baird, manager of Annandale mine, left, and J. I. Horty, editor of The Explosives Engineer.

TWO PROUD VETERANS: These veteran employes, Angelo Calderoni, left, and Frank D. Obidean, unfurling the Sentinels of Safety flag, have worked in the Annandale mine 40 and 41 years, respectively, without a lost-time injury. They expressed pride in being associated with miners who not only established a world's safety record for underground nonmetallic mines but who also won first place in the National Safety Competition.

J. Rich Steers

Glenway W. Maxon

The MOLES AWARDS for 1954

J. Rich Steers and Glenway W. Maxon to become the 14th recipients of the awards given annually by The Moles for outstanding contributions to construction progress

WILLIAM A. DURKIN, chairman of the awards committee of The Moles, a New York association of tunnel builders and heavy-construction operators, announced recently that J. Rich Steers, president of J. Rich Steers, Incorporated, New York City, and Glenway W. Maxon, president of Maxon Construction Company, Dayton, Ohio, have been chosen to receive The Moles Awards for 1954. The awards, considered to be the highest recognition accorded to individuals in the construction industry in the United States for outstanding contributions to the industry, are made each year to an association member and to a nonmember. Mr. Steers, a member, and Mr. Maxon, a nonmember, will become the 14th pair of honorees in a series that was started in 1941. Included among the previous winners are former President of the United States Herbert Hoover, an eminent engineer before his entry into statecraft; General Brehon B. Somervell (retired), wartime chief of the Army Service Forces; Admiral Ben Moreell (retired), wartime commander of the Seabees; Robert Moses, New York City Construction Coordinator; and the late Frank T. Crowe, constructor of the Hoover, Shasta, and other large dams and tunnels.

Official presentation ceremonies will take place at the annual dinner of the association on February 3, at the Waldorf-Astoria Hotel in New York. Reservations for attendance at the dinner have been received from more than 600 prominent contractors, engineers, and manufacturers' representatives.

J. Rich Steers

After two years of service overseas in World War I, J. Rich Steers was graduated from Princeton University, with the class of 1920. Since 1936, he has been president of the New York company which bears his name. During the past 14 years, J. Rich Steers, Incorporated, has experienced an extraordinary expansion of its activities. Especially noteworthy in this rapid-growth program were the construction of shipyards and dry docks for the U. S. Navy; the building of three sections of the East River (Franklin D. Roosevelt) Drive; the completion of large undertakings in the Mediterranean area; and the construction of various major projects in Greece, Tangier, Port Lyautey, and Libya. Total money value of work performed by this company in the past six years approximates $250 million.

Glenway W. Maxon

Glenway W. Maxon, a native of Texas, studied engineering at the Universities of South Dakota and Cincinnati. After 20 years of service with the Corps of Engineers, U. S. Army, as a civilian employe, he resigned to form his own company in 1928. During the past quarter-century, the Maxon Company has completed $700 million worth of construction work involving dams, locks, bridges, defense plants, shipyards, barges, towboats, and installations for the Atomic Energy Commission. At the beginning of 1953, it had contract obligations amounting to more than $200 million.

The citation honoring Mr. Maxon made special reference to the success his company has experienced in the sharing of earnings with the personnel at all levels, through a bonus system for employes from foremen up, and a profit-sharing trust fund for all workmen with three or more consecutive years of employment.

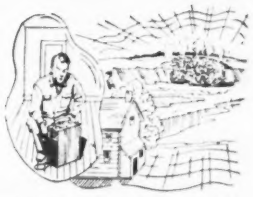
Shallow Exploration for Iron Ore

(Continued from page 174)

History

The particular technique of air shooting employed in the survey described is known as the Poulter Seismic Method, and was developed by Dr. Thomas C. Poulter, formerly associate director of Armour Research Foundation and now associate director of Stanford Research Institute. Discovery and field investigation of the method were first carried on by Dr. Poulter in the Antarctic during 1933 and 1935. In the past five years the Institute of Inventive Research at San Antonio, Texas, and Stanford Research Institute in California have done considerable work in developing the commercial applications of the method. Some of the features of the method were described in greater detail in an article in the January-February, 1949, issue of THE EXPLOSIVES ENGINEER, entitled "Aerial Explosions Help to Find Hidden Oil," by Andrew R. Boone. Today more than a dozen different major oil companies are licensed to employ the Poulter Seismic Method in exploration activities in the oil regions of the world. During the current summer a Stanford Research Institute crew will be using the same techniques north of the Arctic Circle. Thus, a scheme discovered in the Antarctic has covered the globe.

VIBRATION TROUBLES?



EXPLOSIVES USERS—If you are experiencing or anticipate legal or public relations problems arising from blasting effects—

Send For Our **BROCHURE** *Describing Our Services*

"VIBRATION PROBLEMS CONNECTED WITH BLASTING: THEIR SOLUTION AND CONTROL BY SCIENTIFIC METHODS"

(Price Schedule Accompanies Brochure)

VIBRATION ENGINEERING COMPANY

301 Hazleton National Bank Bldg. Phone 5774 Hazleton, Pa.

Dr. L. Don Leet, President, Harvard, Mass.

HAROLD H. WHITE
1831 Picher Ave.
Joplin, Mo.

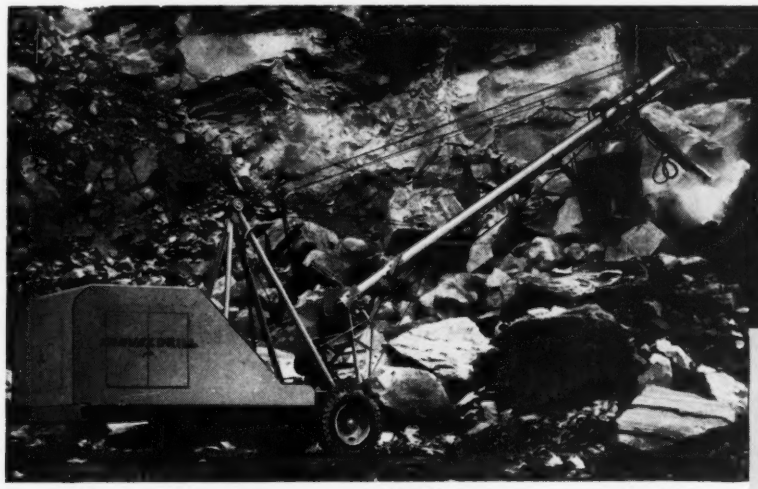
RANALD E. JONES
Jinny Hill Road
Cheshire, Conn.

LEET ASSOCIATES DIV.
Harvard, Mass.

JOHN W. JONES
D. C. TOYE
904 47th Ave., N.E.
Portland 13, Ore.

FOR FUTURE REFERENCE

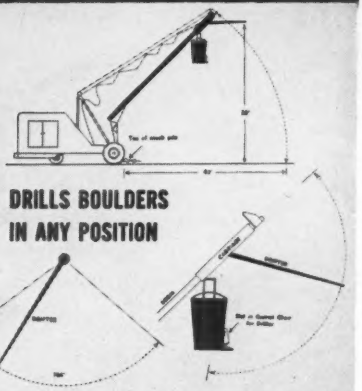
The six issues of THE EXPLOSIVES ENGINEER published in 1953, which comprise Volume 31, will soon be available, bound attractively in cloth. These will be sent to post-office addresses in the United States and Canada for $3.50 each, or for $4.50 to post-office addresses in other countries (limited). Address orders to THE EXPLOSIVES ENGINEER, 990 King Street, Wilmington, Delaware.



In secondary drilling...

A TRAVEL DRILL

solves serious Problems...
builds bigger Profits...
sets new Economy record!



Speed * Economy * Efficiency * Safety

1. Drills over 70 feet per hour in granite gneiss with 37-38 L. A. hardness test. Experienced jackhammer operator made less than 8 feet in same stone.
2. Replaces 6-8 jackhammer operators and their equipment; eliminates much shovel operation time. Cuts drilling costs over 50%.
3. Travels under its own power. Drills from quarry floor to height of 33 feet. Drifter swings in 104° arc. Entire machine driven and operated by one man.
4. Eliminates accidents common to jackhammer operators. Operator works in covered chair at least 6 feet away from boulders being drilled.

Write for full details and free analysis of use in your quarries!

Manufactured and Distributed by

The TRAVEL DRILL Co., Inc.

P. O. BOX 1124 RALEIGH, N. C.

STEEL FORMS: This picture, taken during the early days of activities in the 12-ft. circular north tunnel, shows Palmer Constructors' workmen laying and tying reinforcing steel prior to the placement of steel forms within the tunnel.

Hydroelectric Project

(Continued from page 179)

tunnel roof to the surface, was the first operation in the construction of the tunnel. Then the surge tank was brought down in 5-ft. lifts. Material from the pilot shaft was dropped into a Y of the tunnel and did not interfere with other tunnel operations. During the preparation of this article in September, 1953, the surge tank was being lined with reinforced concrete; about 1,200 cu. yds. will be used in this operation. In the penstock, the reinforced concrete to be used amounts to 3,500 cu. yds., and lining of the tunnel will require about 26,000 cu. yds.

The Lake Eklutna hydroelectric project is expected to be completed, with the powerhouse in operation, by January, 1955.

Project Personnel

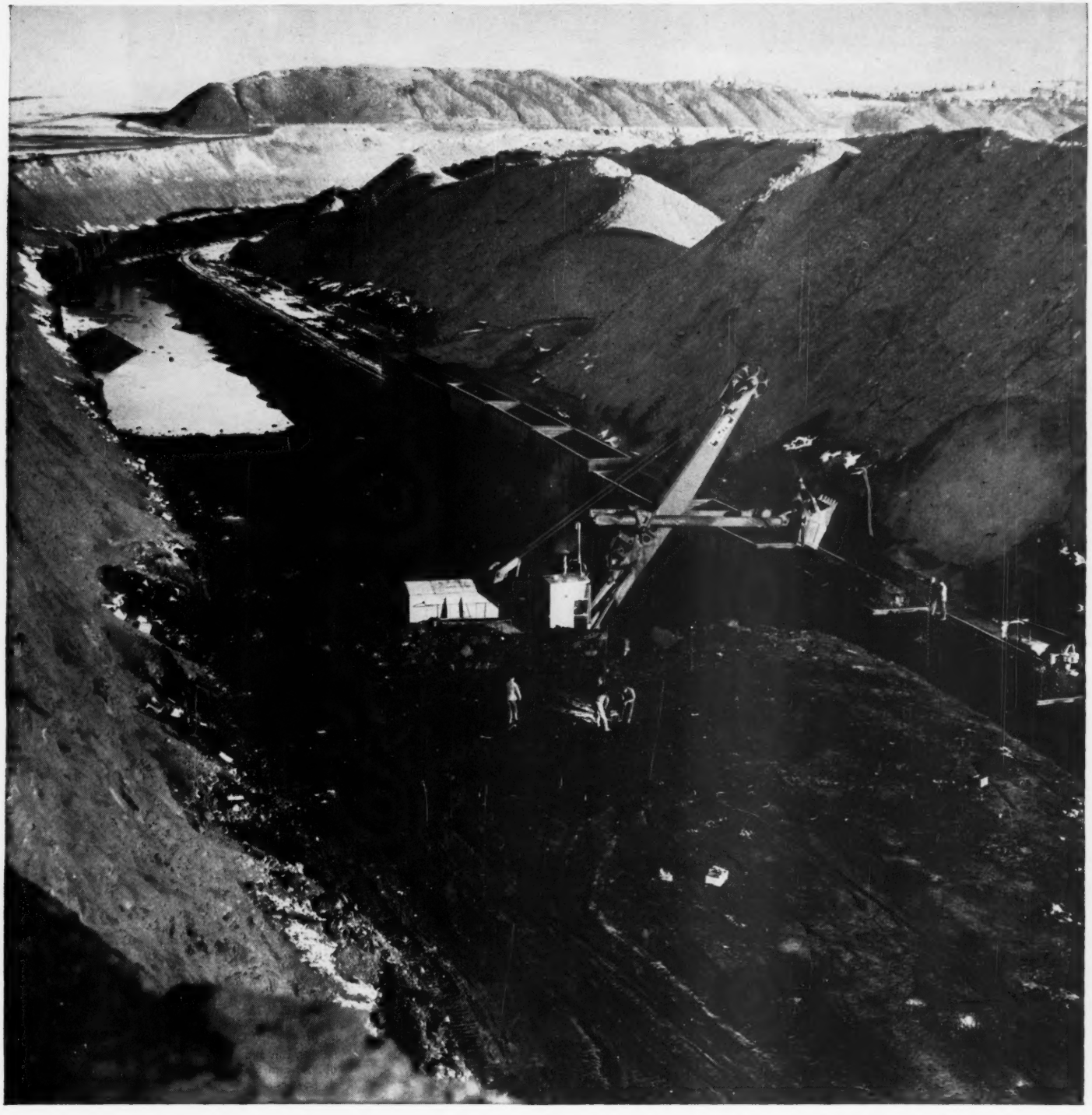
For the Bureau of Reclamation, L. N. McClellan of Denver, Colorado, is chief engineer and L. F. Wylie is construction engineer. The key personnel for the contractor, Palmer Constructors, are Al Coker, president of Coker Construction Company, project manager; William Nixon, assistant project manager; Don R. McGregor, project engineer; Al Aitken, portal superintendent; Ray Blasongame, shaft superintendent; and George W. Mardorf, office manager.

More than 300 men are employed by Palmer Constructors for the initial excavation phases of the project. A camp has been erected in the headquarters area along Glenn Highway, complete with trailer courts, barracks, dining halls, office buildings, and permanent housing for the Bureau of Reclamation personnel.

The Eklutna hydroelectric project is the first large-scale exploitation of potential water-power sites that nature has provided so abundantly in Alaska. It has been estimated that Alaska's river systems, if properly developed, could produce about 50 billion kilowatt hours of energy annually. In a report to the 82nd Congress, the Bureau of Reclamation estimated that the development of the potential hydroelectric sites for low-cost power in Alaska " . . . is a prerequisite of a balanced and mature economy." The report also stated that "nature has provided these power sites so lavishly that even the most remote part of the country is easily within modern power transmission distance."

The development of the Eklutna Lake hydroelectric potential will provide Greater Anchorage and the Matanuska Valley, Alaska's focal point, with low-cost power sufficient to meet the demands of national defense, as well as to provide a base for the advancement of the economy of the area.

UNLOADING MUCK: At the gate shaft, cars filled with muck were unloaded by means of a hydraulic airjack made on the job. A chain around a rail and the frame of the car prevented the car from being raised completely off the tracks.



IMPOSSIBLE WITHOUT EXPLOSIVES

During 1953, stripping operations will account for some 120 million tons of coal, or close to one-quarter of the total annual production. In extreme cases, deposits 150 feet or more below the earth's surface have been mined. For every five feet of coal thickness, an average of 39 feet of overburden first has to be removed. It's a job that never could be handled economically without explosives. Hercules has pioneered in developing the right types of explosives and has the service facilities to help solve any blasting problem concerning coal mining, metal mining, quarrying, construction, petroleum.

HERCULES POWDER COMPANY
INCORPORATED

Explosives Department, 990 King St., Wilmington 99, Del.

Birmingham, Ala.; Chicago, Ill.; Duluth, Minn.; Hazleton, Pa.; Joplin, Mo.; Los Angeles, Cal.; New York, N. Y.; Pittsburgh, Pa.; Salt Lake City, Utah; San Francisco, Cal.

XR53-5

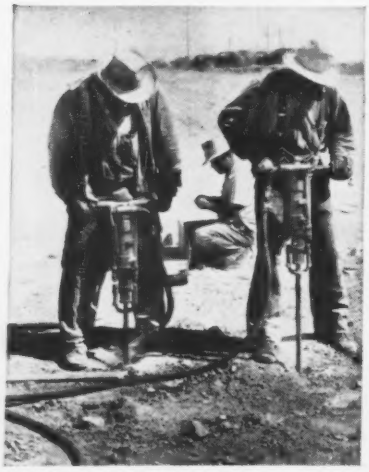
Le Roi *gives you more for your money!*

MORE AIR POWER! MORE FOOTAGE! MORE PROFITS!

Le Roi-CLEVELAND Sinkers are available in sizes from 18 to 80 lbs., with advantages you want. They use less air. They're easy to handle—operators don't tire easily. And they have what it takes to drill more feet per shift: Strong rotation. Powerful blow. High drilling speed.

Tractair is a combination 35-hp tractor and 105-cfm compressor that takes air power anywhere. Here, it operates two Le Roi-CLEVELAND backfill tampers. Can also be used for breaking, drilling — and, when equipped with front-end loader, for digging, loading, lifting, backfilling, snow-plowing, etc. This way, Tractair cuts costs and saves you the extra expense of special equipment.

Le Roi-CLEVELAND DR30 Wagon Drill puts deep holes down faster, with less air, than any other wagon drill available. Uses 4" bore Le Roi-CLEVELAND Drifter. Has strong rotation, powerful hole-cleaning ability, and high drilling speed with big bits. For shallow holes, the lightweight Le Roi-CLEVELAND DR34 is available.



Get air jobs done faster!

with Le Roi Airmaster Compressors and Le Roi-CLEVELAND Air Tools

There are 9 sizes of Airmasters — and 14 models—ranging from 60 cfm to 600 cfm. A 600-cfm diesel unit is shown here. It's got the capacity to operate two deep-hole wagon drills with plenty of air to spare for other tools.

Every Airmaster is powered by a heavy-duty Le Roi engine designed especially for compressor service.

Le Roi-CLEVELAND Paving Breakers are available in sizes from 18 to 80 lbs. They really pack a wallop—make short work of breaking up the hardest concrete. Protective air cushion in front end assures long life. Well balanced for easy handling. Operators like them — and get more done.

YOU make the most of air power—speed your work and keep costs down — when you team up Le Roi Airmaster Compressors and Le Roi-CLEVELAND Air Tools. Here's why:

First of all, a Le Roi Airmaster gives you more air capacity for less money. You can get an Airmaster that's *exactly right* for size — one that's not too big or too little for the job to be done — one that lets you do the most work at the least cost. That's because Le Roi has the industry's widest range of sizes to choose from.

You're ahead other ways, too: Airmaster's full-pressure system delivers *all* the air you call for, *when* you call for it. Conservative rating of the Airmaster engine provides ample power reserve — for lower fuel consumption, less maintenance, lower operating costs. Magneto ignition gives you quick, easy starting — saves time — lets you get going faster.

Now, the best way to use the low-cost air produced by Airmaster is to let it power Le Roi-CLEVELAND Air Tools. They're built to really take punishment — and to break more pavement, dig more clay, drill more rock, tamp more fill.

Enjoy Le Roi air-power advantages. Use Le Roi Airmaster and Le Roi-CLEVELAND Air Tools on your next job — and watch costs drop. See your Le Roi distributor. Write for latest bulletins.

Compressors
Rock Drills
Tractair
Engines . . .

LE ROI COMPANY MILWAUKEE 14, WISCONSIN

A Subsidiary of Westinghouse Air Brake Co.

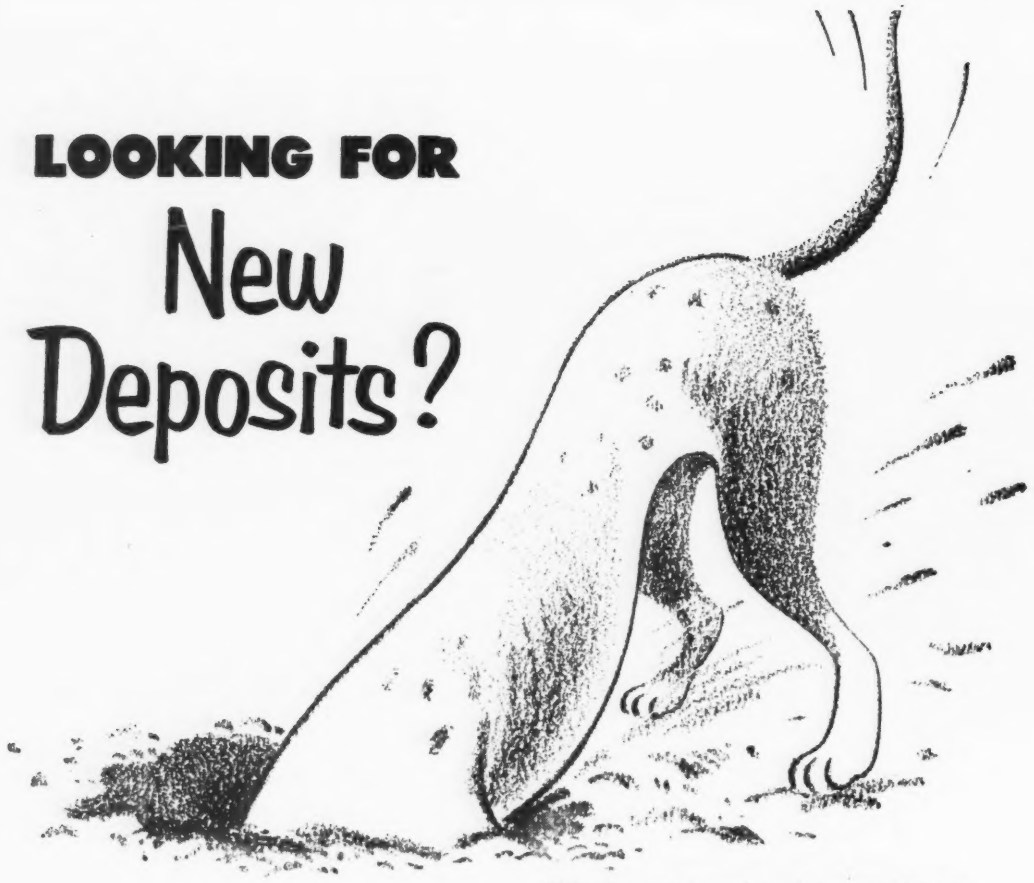
Plants: MILWAUKEE • CLEVELAND • GREENWICH, OHIO

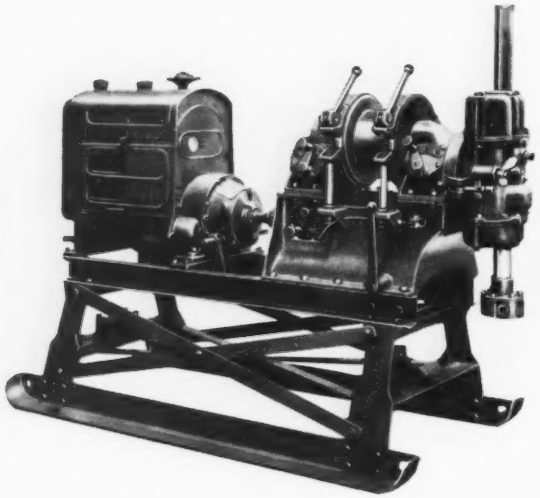
Nation-Wide Sales-Service Network

ALABAMA: Birmingham, Mobile — ARIZONA: Phoenix — ARKANSAS: Little Rock — CALIFORNIA: Bakersfield, Long Beach, Los Angeles, San Francisco — COLORADO: Denver, Grand Junction — CONNECTICUT: Hartford — FLORIDA: Jacksonville, Miami, Tampa — GEORGIA: Augusta, Decatur — IDAHO: Boise, Idaho Falls, Twin Falls — ILLINOIS: Chicago — INDIANA: Indianapolis — IOWA: Cedar Rapids, Des Moines, Waterloo — KANSAS: Great Bend, Kansas City, Pratt, Wichita — KENTUCKY: Lexington, Louisville — LOUISIANA: New Orleans, Shreveport — MAINE: Augusta — MARYLAND: Baltimore, Hyattsville — MASSACHUSETTS: Hyde Park, Newton Highlands, Worcester — MICHIGAN: Detroit, Grand Rapids — MINNESOTA: Duluth, Minneapolis — MISSISSIPPI: Jackson — MISSOURI: Joplin, St. Louis — MONTANA: Billings, Great Falls, Kalispell, Missoula — NEBRASKA: Omaha — NEW HAMPSHIRE: Manchester — NEW JERSEY: Cranford, Kingston — NEW MEXICO: Albuquerque — NEW YORK: Albany, Binghamton, Buffalo, Long Island City, Newburgh, Rochester, Saugerties, Syracuse, Whitesboro, Woodside (L.I.) — NORTH CAROLINA: Charlotte — OHIO: Cincinnati, Cleveland, Columbus, Dayton, Toledo — OKLAHOMA: Oklahoma City, Tulsa — OREGON: Portland — PENNSYLVANIA: Bethlehem, Harrisburg, Philadelphia, Pittsburgh — RHODE ISLAND: Providence — SOUTH CAROLINA: Columbia — SOUTH DAKOTA: Rapid City, Sioux Falls — TENNESSEE: Chattanooga, Knoxville, Memphis, Nashville — TEXAS: Dallas, El Paso, Houston, Lubbock, San Antonio — UTAH: Salt Lake City — VIRGINIA: Richmond, Roanoke — WASHINGTON: Seattle, Spokane — WEST VIRGINIA: Clarksburg, South Charleston — WISCONSIN: Milwaukee — WYOMING: Casper.

C-145

LOOKING FOR New Deposits?



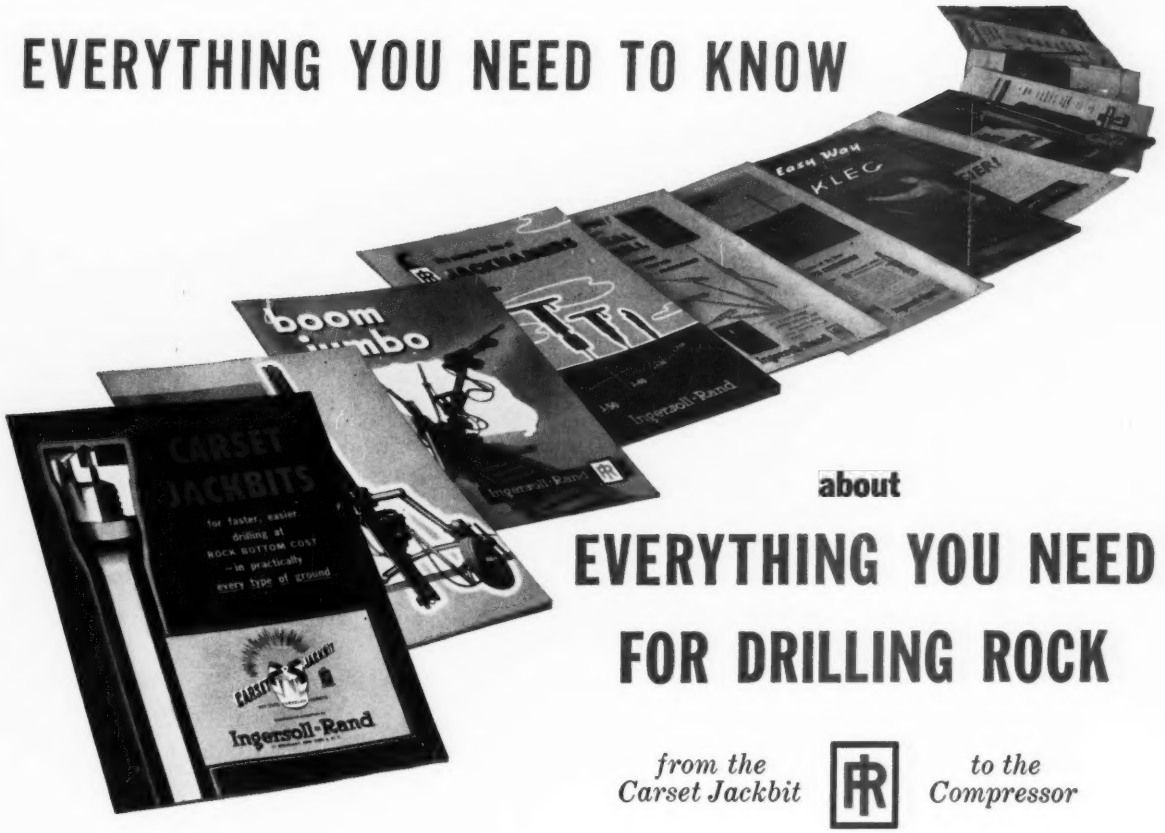


Whether you're mineral prospecting or looking for extensions of existing deposits, you'll wind up with the right information easier and faster by using the skid mounted CP-8 and CP-15 Diamond Core Drills. Specifically engineered to withstand the continued high drilling speeds made possible by bortz bits, they're available with gas, diesel or electric drive for surface drilling and air drive for sampling underground. And they can be readily moved from hole to hole under their own power. Bolted frame permits easy disassembly for transportation to remote sites. With E-EX fittings the CP-8 has capacities to 1250 ft., the CP-15 to 2250 ft. For more complete information, write: *Chicago Pneumatic Tool Company, 8 East 44th Street, New York 17, N. Y.*

Chicago Pneumatic

PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AVIATION ACCESSORIES

EVERYTHING YOU NEED TO KNOW


boom jumbo
CARSET JACKBITS
for faster, easier drilling at ROCK BOTTOM COST —in practically every type of ground
Ingersoll-Rand

about

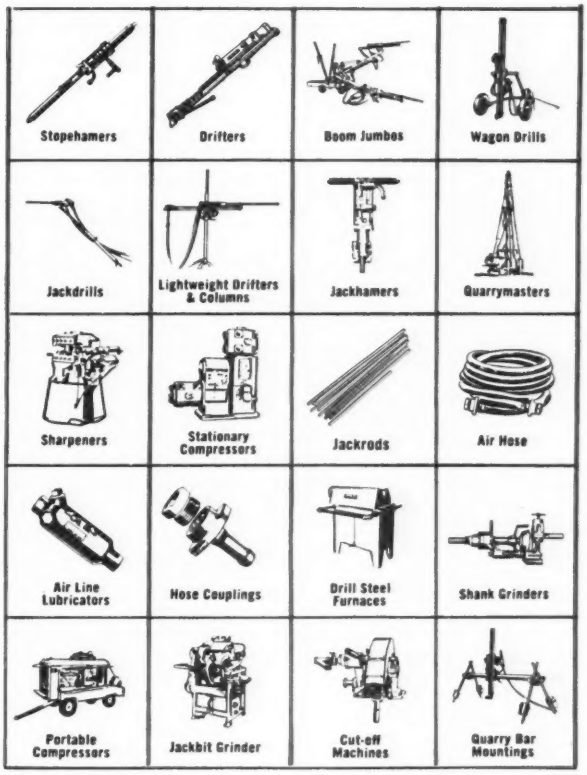
EVERYTHING YOU NEED FOR DRILLING ROCK

from the Carset Jackbit **IR** *to the Compressor*

No matter what your rock drilling problem is, you can be sure that Ingersoll-Rand can help you. The complete I-R line of rock drilling machinery is backed by 80 years of specialized experience—in designing, building, installing, operating and servicing everything from the bit all the way back to the compressor.

This one-source of supply, with undivided responsibility, pays-off in many ways . . . better service, coordinated equipment that's designed to work together, and smaller spare parts inventories. It all adds up to faster, easier rock drilling, at lower over-all cost.

Write, wire or 'phone your nearest Ingersoll-Rand office for any information or any rock drilling equipment you need.



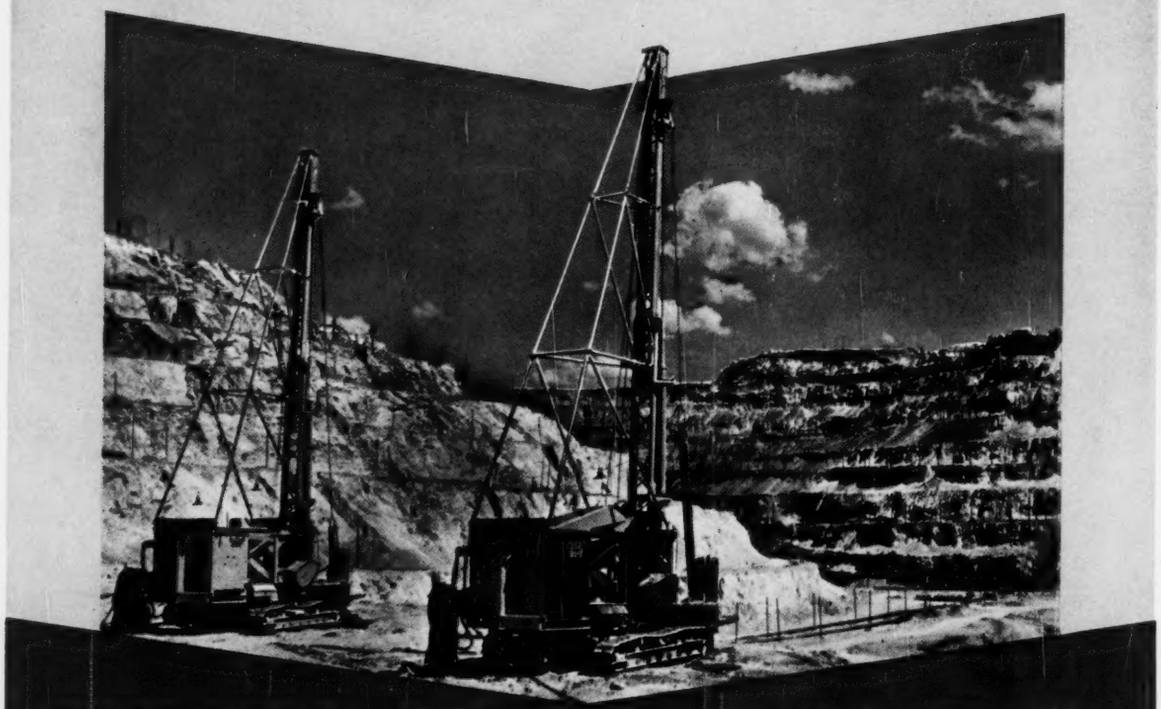
Ingersoll-Rand
11 Broadway, New York 4, N. Y.

839-5

ROCK DRILLS • COMPRESSORS • AIR TOOLS • CENTRIFUGAL PUMPS • TURBO BLOWERS • CONDENSERS • DIESEL AND GAS ENGINES

Give Your Operator the OUTFIT

He'll Give You the OUTPUT!



BUCYRUS-ERIE Blast Hole Drills

With an easy-to-handle Bucyrus-Erie blast hole drill your operator has a machine designed to give him the most in work capacity — at minimum of effort.

Give your operator the best — give yourself the most speed and lowest cost in blast hole drills — get a Bucyrus-Erie. Four models — hole capacities from 5⅝ to 12-in.

BUCYRUS-ERIE COMPANY

SOUTH MILWAUKEE, WISCONSIN

EASY-REACH CONTROLS Control levers are grouped within easy reach of the operator and require only a light touch. A driller can run this rig at top speed for long periods without fatigue slowdown.

BUILT-IN TOOL WRENCHES (on all except 22-T) Speed tool changing — eliminate back-breaking hand wrenching.

LESS JOLTS AND BOUNCE Bucyrus-Erie's derrick head shock absorber not only means faster hole — but in addition it takes up the jolts that would otherwise shake up both machine and operator.

EASIER SET-UPS Hydraulic leveling jacks (standard on the 50-T, special on the 29-T) are operated from the platform for fast, easy leveling — without special ground preparations. Built-in stabilizing jacks (standard on 22-T, 27-T and 29-T) provide quick 3-point set-ups.

9B53C